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JAGGER (I. C.). **Bacterial leaf-spot disease of Celery.**—*Journ. Agric. Res.*, xxi, 3, pp. 185–188, 2 pl., 1921.

The cause of this celery disease, which occurs chiefly in the States of New York and Michigan, is *Pseudomonas apii*, n. sp. (group no. 211.2322033). The spots are of a rusty brown colour, irregularly circular in outline, and rarely exceed 5 mm. in diameter. They can be distinguished from *Septoria* leaf-blight spots only by the absence of pycnidia. Whilst in severe cases older leaves are killed by the bacterium, the injury usually consists in the disfiguring of the foliage and possibly in a reduction in growth of the plants. Leaf blades are the principal parts attacked, the petioles seldom, if ever, suffering from the disease. Inoculations on parsley (*Petroselinum*) failed. Details of the morphological and cultural characters of the pathogen are given.

The disease can be very well controlled by spraying with Bordeaux mixture, but not with lime-sulphur.

SMITH (E. F.) & GODFREY (G. H.). **Bacterial wilt of Castor bean (Ricinus communis L.).**—*Journ. Agric. Res.*, xxi, 4, pp. 255–261, 13 pl., 1921.

Inoculations, by means of delicate needle pricks, of cultures of *Bacterium solanacearum*—the causal organism of this wilt—produced the disease in a more or less pronounced degree in the following plants: tomato, nasturtium (*Tropaeolum majus* L.), cotton (only young seedlings), vanilla (*Vanilla planifolia* Andrews), sunflower (*Helianthus annuus* L.), garden balsam (*Impatiens balsamina* L.). The authors also obtained successful inoculations on a series of jimson weeds (*Datura stramonium* L.), and fuchsias were shown to be equally susceptible.

Extensive investigations carried out in Florida seem to point to the soil as being an influencing factor in the appearance or otherwise of the wilt. It is surmised that the disease is more likely to develop on newly-cultivated land than in fields that have been bearing crops for many years. At any rate, facts observed so far bear out this contention. The disorder is likely to prove fatal to

small *Ricinus* plants, two or three inches high, but it is also found in larger specimens up to several feet high, and the wilting may be sudden or it may come about slowly. The first signs of the disease often appear after a period of wet weather of several days' duration. More of the wilt is seen in hot, dry weather. A plant may recover temporarily during moist weather or during a cool night following a hot, dry day. In the more severe cases death is the ultimate result, while in others, where the attack had not been severe enough for a fatal termination, a marked dwarfing of the plants resulted; this appears to be typical.

Plants observed in the vicinity of Miami, Fla., and at other points, especially in heavy soils, showed signs similar to wilt, but this was found to be more likely due to asphyxiation of the roots caused by too high a water table. The bacterial wilt is distinguished from this and other known diseases of the castor bean by the typical browning of the vascular system near the base of the plant, which is more or less pronounced, and extends in some cases into the woody part of the stem. In addition to this symptom, it is always possible, with the aid of a good hand lens, to observe drops of bacterial exudate at the freshly cut ends of the vascular tubes, especially if the plant is still green.

MATSUMOTO (T.). **Studies in the physiology of the fungi. XII. Physiological specialization in Rhizoctonia solani Kühn.**—*Ann. Missouri Bot. Gard.*, viii, 1, pp. 1–62, 6 figs., 1921.

Rhizoctonia was isolated from potato, bean, lettuce, dahlia, egg-plant, and *Habenaria* sp., principally from California and Missouri. Fifteen isolations were studied, but these were reduced by preliminary tests to six types which were studied intensively. Some strains blacken potato agar during growth and others do not, while there is also a considerable difference in their rate of growth at 38° C. and other temperatures. All six strains hydrolysed starch and inverted cane sugar, but there was marked variation in enzyme activity between different strains. Maltose was used by the fungi about as readily as dextrose, but lactose seemed to have much less nutritive value; the strains differed also in their utilization of these sugars. All the strains utilized inulin, glucose, fructose, galactose, and amygdalin without evidence of much specialization. Cellulase was present in the mycelium in somewhat variable amounts.

The various strains of *Rhizoctonia* differ in their nitrogen metabolism, as evidenced by their growth with casein, peptone, asparagin, and legumin. No strain utilized caffeine. Potassium nitrate, ammonium sulphate, and ammonium nitrate are available sources of nitrogen, potassium nitrate being preferable. Only two strains could utilize potassium nitrite and these with two others caused some reduction of nitrate; one strain produced no reduction. Trypsin and erepsin were present in all strains. The fungi grow best on acid media, the favourable hydrogen-ion concentration being about P_H 3·8. The strains varied in their tolerance of acid and alkali; in general, they increased the active acidity of the medium during growth. Inadequate aeration repressed growth and the formation of sclerotia.

Fusion was found to occur between hyphae arising from different mycelia of the same strain, and between hyphae of certain similar strains. Two strains would each fuse with none of the others.

Inoculation tests on beans, lettuce, potatoes, and eggplants showed that certain strains would attack all these hosts, others only certain hosts, and two strains attacked none of them. The highest pathogenic capacity was manifested when inoculation was made on the host from which the culture originated. The pathogenicity of one strain was somewhat modified by transfer to a host plant different from that from which it was originally obtained. The growth characters of another form on liquid media were changed (apparently permanently) after successive transfers on other culture media.

Infection of a host takes place most readily through the roots, and penetration was found to be mechanical, the fungi entering directly through the cuticle.

The strain from potato stem from California and one from *Habenaria* were considered identical, of importance pathologically, and perhaps the same as the 'new strain' of Rosenbaum and Shapovalov (*Journ. Agric. Res.*, ix, p. 413, 1917). Strains from sclerotia on potato tuber from Missouri, and from stem of navy bean from California, were considered to be two specialized forms of the same fungus. A strain from a potato stem from California was found to have much smaller hyphae (3–6 μ in diameter, in contrast to a diameter of 7–14 μ in the other strains), it produced no reduction of potassium nitrite, would fuse with no other strain studied, and was not found to be pathogenic. This strain may prove to be a distinct species. The sixth strain was insufficiently studied to admit of definite conclusions as to its taxonomic relations.

APPEL (O.). **Die wirtschaftliche Bedeutung der Pflanzenkrankheiten und die Mittel zu ihrer Bekämpfung.** [The economic importance of plant diseases and the means of controlling them.]—Reprinted from *Arbeiten der deutschen landwirtsch. Gesellsch.*, cccxiv, 18 pp., 1921.

The economic importance of plant diseases can hardly be overestimated. According to Eriksson the annual losses from rusts in cereals in all the grain-growing countries amount to $1\frac{1}{4}$ milliards of marks [gold marks are intended throughout]. The rust epidemic of 1891 is calculated to have caused a loss in wheat and rye of some 170 million marks in Germany. In 1911 Bavaria lost 26 million and in 1916 Saxony 47 million marks from yellow rust. The losses from smut must be almost as great, although exact statistics for Germany are not available. In a normal year, however, the damage to winter wheat in Saxony from smut fungi was calculated to be $6\frac{1}{2}$ million marks. It must be remembered that these and similar figures represent only a fraction of the total losses of cereals due to disease. Losses in storage are also very great. Taking the losses caused by all pests to stored grain at 5 per cent., the storage losses in cereals during the harvest year 1916 are calculated to have amounted to approximately 1,102,364 tons in Germany, while an average annual loss of 10 per cent. can be allowed with

considerable accuracy for stored potatoes. Potato blight (*Phytophthora*) reduced the potato yield by one-third, valued at about $2\frac{1}{2}$ milliard marks [? gold marks], in 1916. Approximate statistics only are available for fruit-growing, but estimating the average annual pre-war value of the fruit crop at 360 million marks, the total in favourable years was 25 per cent. above this figure and in unfavourable ones 25 per cent. below it. Thus there is an approximate difference of 180 million marks between the highest and lowest yields, of which at least 50 per cent. is attributable to pests and diseases. The destruction of conifers and other trees by insect and fungous pests is equally responsible for considerable monetary losses. Thus the single fungus *Trametes pini* is responsible for an annual loss of several million marks in Germany; whole stands of trees of various sorts are not seldom affected by the honey agaric; and the incidence of blister rust on Weymouth pines frequently reaches 30 to 40 per cent. In 1910 a 200 hectare plantation of 40 to 80 year old oaks in Croatia was entirely destroyed by mildew, and not only are similar cases known in Germany but it has been found that the stunting effects of ordinary attacks of this fungus are so great that it takes eight years for affected trees to make a growth equal to that of healthy ones in five years.

The various methods of preventing and controlling plant diseases are briefly reviewed, and the necessity for an extension of government regulations in dealing with plant diseases is urged. It is stated that during the war the incidence of smut on wheat increased to such a degree, in consequence of the scarcity of fungicides, that fields with 10 to 20 per cent. of smutted ears are not uncommon, while others with as much as 60 to 70 per cent. can be found. Steeping wheat seed grain as a precaution against bunt is now generally recognized as essential, and has actually been made compulsory, with very satisfactory results, in Würtemberg. Many of the larger seedsmen are now supplying steeped seed, and recently there has been a growth of the practice of treating wheat and barley against loose smut by the methods introduced in Germany not only in large scale apparatus suitable for handling considerable quantities but also on smaller farms. The stripe disease of barley is being treated in the same way. Extensive precautions are also being taken in Bavaria to exterminate the snow-fungus (*Fusarium nivale*), the amount of disinfected seed having increased from 900 cwt. in 1911 to 100,122 cwt. in 1913. The shortage of copper and sulphur (of which the requirements for agricultural purposes in 1915 were 5,800 and 5,000 tons respectively) led to the introduction of substitutes and secret preparations, the latter industry assuming such a dangerous extension as to demand government interference. There is no lack of guidance in the practical measures required to check plant diseases in Germany, the State Biological Station at Dahlem alone having distributed over $6\frac{1}{2}$ million leaflets up to 1918.

ASHBY (S. F.). **Report of the Microbiologist, 1920.**—*Ann. Rept. Dept. of Agric. Jamaica for 1920*, pp. 24–25, 1921.

In bananas the Panama disease or banana wilt is on the whole under good control, though a few new cases have occurred in

hitherto uninfected localities. Trash collected at the fruit-receiving dépôts is a probable source of infection, against which cultivators are warned.

In coco-nuts a few cases of bud-rot have been observed, but the incidence of this disease was restricted by the drought of 1919–20. The leaf-bite diseases have ceased to occur in the epidemic form which followed the hurricane years 1915–17, and many trees have thrown off the attack naturally. The prevalence of die-back has increased, apparently in connexion with the drought. Recently a species of *Rhizoctonia* and a *Pythium* have been isolated from partially diseased roots of trees affected with this disease, and these fungi are probably important factors in bringing about root deterioration. In Hawaii a species of *Pythium* has been isolated from the roots of cane, banana, taro, pineapple, and rice, and found to cause the decay of cane roots inoculated with it in sterilized soil. Both *Rhizoctonia* and *Pythium* have also recently been found associated with root disease of sugar-cane in Porto Rico. Coco-nut trees affected with die-back should be treated in such a way, when not too old, as to promote regeneration of the roots. Forking, removal of immature nuts, and the application of bluestone to the soil round the trunks may help to restore such trees.

The mosaic disease of sugar-cane is somewhat widely distributed, but does not as a rule occur in a severe form. A serious reduction of tonnage on account of this disease has been found in all the cultivated varieties, though Transparent withstands it better than the ribbon varieties. Some seedlings, such as B 208 and B 3922, are severely affected. Uba (Kavangire) appears to be immune in Jamaica. The practices of seed-piece selection and roguing out of affected plants from the young crop are recommended.

SNOWDEN (J. D.). **Report of the Government Botanist for the period 1st April to 31st December, 1920.**—*Ann. Rept. Dept. of Agric. Uganda for the nine months ending December 31, 1920*, pp. 43–46, 1921.

This report consists chiefly of notes on the diseases of plants in Uganda arranged under the following heads:—

COFFEE. *Hemileia vastatrix* B. and Br., frequently succeeded by 'die-back' (*Colletotrichum coffeanum* Noack), was prevalent. Recent experiments by Small [see this *Review*, i, 1, p. 3] indicate that the various *Colletotrichums* attacking coffee, cacao, tea, and fruit trees in Uganda are closely related to one another, or perhaps only varieties of the same fungus. Pure cultures of *C. coffeanum* produce a *Glomerella* indistinguishable from *G. cingulata* (Stonem.) S. and v. Sch. The writer has also found a *Glomerella* stage associated with *C. coffeanum* on dead twigs of coffee in the field. *C. camelliae* Mass. on tea is one conidial form of *G. cingulata*, and another form has been found during the year on the Avocado pear. Root diseases (*Hymenochaete noxia* and (?) *Sphaerostilbe repens* B. and Br.) were not much in evidence, while the damage caused by the following fungi, recorded in previous years, was also negligible:—

Cercospora coffeicola B. and Cke, *Fusarium coffeicola* P. Henn., *Periconia byssoides* Pers., *Phoma* sp., *Phomopsis* sp., *Septoria*

coffeae Wakef., *Capnodium brasiliense* Puttem., and *Polyporus coffeae* Wakef.

RUBBER. Bark and cortex diseases seem to be on the increase. Black thread, generally considered to be due to *Phytophthora* sp., was very prevalent at Kampala, nearly 50 per cent. of the total number of tapped trees being affected in some cases. Reports from other plantations indicate that brown bast is the more serious disease, but only two cases were seen at Kampala. There were a few cases of *Botryodiplodia theobromae* Pat., but root diseases (the same two as on coffee have been recorded) were unimportant. There is no authentic record as yet of *Ustulina zonata* (Lév.) Sacc. on *Hevea* in Uganda. Parasites of minor importance on rubber are *Cephaleuros mycoidea* Karst. and *Phyllosticta ?hevea* Zimm. on leaves; *Coniothyrium* sp. causing a canker on stems and branches; *Gloeosporium alborubrum* Petch on young stems; *Pestalozzia palmarum* Cke and *Leptosphaeria* sp. on apices of stems; *Phoma heveae* Petch, and *Phomopsis* sp. on branches; *Megalonectria pseudotrichia* Speg. and *Fusarium* sp. on dead bark; *Tubercularia versicolor* Sacc. on the healing surface of tapped bark; and *Helicobasidium* sp. on roots.

CACAO. Die-back, due to *Botryodiplodia theobromae*, was prevalent and severe, the trees in many cases being killed right down to the ground. The action of the fungus is very rapid and the dead leaves remain on the branches, giving the tree a scorched appearance. Cacao has been somewhat neglected of late, and die-back is consequently on the increase. The spores of this fungus can infect *Hevea*, so that great care should be taken to destroy all diseased branches. Pod-rot (*Phytophthora faberi* Maubl. and *Colletotrichum* sp.) and hardening of pods (*Colletotrichum incarnatum* Zimm.) are fairly common, while *C. theobromicola* Del. causes a die-back of twigs. *Capnodium brasiliense, Cephaleuros mycoidea, Phyllosticta* sp., *Megalonectria pseudotrichia*, and *Nectria flavolanata* B. and Br. are of little economic importance.

TEA. Both old and young leaves are attacked by *Colletotrichum camelliae*, one of the conidial stages of *Glomerella cingulata*, with which a *Pestalozzia* is sometimes associated. A *Pestalozzia* is also found on the discoloured spots caused by mosquito blight (*Helopeltis bergrothii*) but it has not yet been ascertained whether it can attack uninjured leaves. *Cephaleuros mycoidea* does comparatively little damage.

FRUIT TREES. *Glomerella cingulata* (found in both conidial and perithecial stages) causes a fruit rot and die-back of twigs of Avocado pear. The conidial stage of a very similar fungus has been reported on the fruits of *Anona muricata* growing in the vicinity of the Avocado pear. Citrus-trees are attacked by *Colletotrichum gloeosporioides* (Penz.) Sacc. and bananas by *Gloeosporium musarum* Cke and Mass. Other parasites which occasionally occur are *Cephaleuros mycoidea* on Avocado pear and guava, *Puccinia pruni* Pers. on peach leaves, and (?) *Sphaerostilbe repens* on the roots of the mango.

COTTON. Much damage is done to the bolls in wet weather by *Glomerella gossypii* Edg. with its conidial stage *Colletotrichum gossypii* Southw. The stems are also attacked at times by this

fungus. *Ramularia areola* Atk. (grey mildew) was fairly prevalent on the leaves, sometimes accompanied by a *Macrosporium* which produces large discoloured patches. A species of *Botryodiplodia* was found causing a die-back of the stems. These diseases appear to be on the increase, and strict attention should be paid to the annual burning of the plants in order to keep them in check. *Cercosporella gossypii* Speg. and *Uredo gossypii* Lagerh. have also been recorded on cotton in Uganda.

MINOR CROPS. Sugar-cane leaves are attacked by *Leptosphaeria sacchari* van Breda which does little harm. Much damage was done to wheat by *Puccinia triticina* Eriks., recorded for the first time in Uganda. It was accompanied by (?) *Helminthosporium sorokinianum* Sacc., also reported for the first time. *Puccinia graminis* Pers. and *Ustilago tritici* Jens. were recorded on wheat in previous years, as were *Sphacelotheca sorghi* (Link) Clint. and *S. reiliana* (Kuehn) Clint. on sorghum. Rice was attacked by a *Helminthosporium* and a *Leptosphaeria*. The leaves are covered with yellowish-brown spots and have the appearance of being scorched by fire. *Puccinia sorghi* is the only disease of maize hitherto reported. The leaves of *Voandezia subterranea* ('mpandi') on the Kampala plantations were attacked by a *Cercospora*, probably an undescribed species. Other parasites which occasionally attack pulse crops in Uganda are *Aecidium vignae* Cke on *Vigna sinensis* and *V. catjang*; *Aecidium glycines* P. Henn. on *Glycine javanica; Ascochyta phaseolorum* Sacc. on *Vigna catjang; Cercospora personata* (B. and C.) Ellis on *Arachis hypogoea; Erysiphe polygoni* DC. on *Pisum sativum; Meliola bicornis* Wint. on *Glycine javanica*, and *Uromyces appendiculatus* (Pers.) Link on beans and *Vigna sinensis*. The leaves of cassava (*Manihot utilissima* and *M. palmata*) are frequently attacked by *Cercospora Henningsii* Allesch. but little harm is done. Ceara rubber (*M. Glaziovii*) is attacked by *C. cearae* Petch. Potatoes at Kampala were severely damaged by (?) *Alternaria solani* (E. and M.) Jones and Grout, the foliage being almost entirely destroyed and the growth of the tubers arrested. Native tobacco is sometimes attacked by *Cercospora raciborskii* Sacc. and Syd.

PUTTICK (G. F.). **The reaction of the F_2 generation of a cross between a common and a durum Wheat to two biologic forms of Puccinia graminis.**—*Phytopath.*, xi, 5, pp. 205-213, 1921.

The author, at the Minnesota Station, made a study of the parasitic capabilities of two biologic forms of *Puccinia graminis tritici* on the F_2 generation from a cross between *Triticum vulgare* (var. Marquis) and *T. durum* (var. Mindum). The Marquis parent was susceptible to one form of the rust, and Mindum resistant to this form; Marquis was resistant and Mindum susceptible to the other form of rust. The forms of rust used had been studied previously and found to be constant. Each F_2 plant was inoculated with both forms: with one form when the seedlings were about eight days old; and later on, after the results of the infection with this form had been recorded, the infected leaves were removed, and inoculations were made with the other form. It was found to be more difficult to infect older plants than to infect seedlings, but the

difference was attributed to the fact that older plants retained a film of moisture less easily than seedlings.

The data obtained on the reaction of each of the F_2 plants are given in detail. All gradations between complete susceptibility and immunity to both forms of rust appeared in the F_2 generation. Since biologic forms differ in their parasitic capabilities on the same variety of wheat, their genetic composition cannot be the same. Each of the two tried was, however, of constant genetic composition since the action of each was uniform. The factors of susceptibility must be located in the host plant. Possibly a single pair of genetic factors, with modifying factors to account for the various grades of infection obtained, may explain the manner of reaction to one of the forms of rust used, but evidence of a similar condition in the case of the other form of rust was not obtained. Of a total of 388 F_2 plants tested, thirty-five were highly resistant to both forms of rust. The author considers that varieties of wheat commercially resistant to stem rust over fairly extensive crop areas can be produced.

ROSEN (H. R.). **The behaviour of telia of Puccinia graminis in the south.** - *Mycologia*, xiii, pp. 111-113, 1921.

P. graminis is rarely found on barberry in the southern portions of the United States, and in general is less destructive on cereals there than the leaf rusts. The stem rust is, however, often prevalent on *Agrostis palustris*, *Phleum pratense*, and *Elymus australis*. Teleutospores are not commonly produced in Arkansas, and in general are undersized and abnormal, and fail to germinate in the spring. An exception is found in the case of *Elymus australis*, which may develop considerable amounts of the teleuto-stage, with normal spores which germinated profusely the following spring. *Berberis trifoliolata* was infected artificially by the sporidia produced.

RAND (F. V.) & CASH (LILLIAN C.). **Stewart's disease of Corn.**— *Journ. Agric. Res.*, xxi, 4, pp. 263-264, 1921.

This wilt, caused by *Aplanobacter stewarti* (E. F. S.) McCul., has been observed in most parts of the United States, but not in Minnesota, Wisconsin, Michigan, northern New York, Vermont, New Hampshire, and Maine. Cultures of the causal organism have been obtained from most localities where the disease has been noted by the authors, and experiments have proved that it is transmitted neither through the soil nor by proximity to diseased stalks, but that the seeds of affected plants are the most probable carriers as the organism has been isolated from their endosperm.

Under 20 per cent. infection usually occurs, but instances of 100 per cent. infection have been met with among the earlier varieties. Moisture and high temperature favour the development of the disease, and it has been found that anything which retards the germination and early development of the seedling lessens the chances of infection from the seed. The latter, if infected, may be rendered safe for planting by a dry heat 'pasteurization' at 60° to 70° C. for one hour. Other control methods are still in the experimental

stage, but it seems clear that northern-grown seed is less likely to carry infection than that grown further south.

HENNING (E.). **Den växthygieniska betydelsen av lerslagning eller sandkörning av uppodlade Kärr- och Mossmarker. I. Förberedande studier och försök.** [The value of clay or sand as fertilizers for crops grown in reclaimed swamps and bogs. I. Preliminary studies and experiments.]—*Meddel. Centralanst. för försöksvä-endet på Jordbruksområdet*, 214, 36 pp., 2 pl., 1921.

The writer has been continuing experiments commenced in 1918 (*Meddel.* 179) to confirm his statement that the admixture of clay in marshy soil prevents the occurrence of the 'yellow-tip' disease of oats which is prevalent on such soils. The history of the reclamation of swamps and bogs in Scandinavia is briefly outlined, together with the fertilizer experiments carried out by various societies interested in the matter.

The 'yellow-tip' disease is evidently of a purely physiological character, no parasitic fungi having been detected during repeated investigations carried out in various localities and extending over a period of two years. It seems to be due to malnutrition caused by lack of moisture at a certain stage of development. Drought prevents the plants from assimilating the nutrient elements of the soil, though the author's experiments have shown that this can to a certain extent be counteracted by the use of artificial fertilizers or farmyard manure.

The yellowish-brown colour of the plants, which spreads outward from the midrib, is considered to be symptomatic of a lack of potassium in the soil. Analyses of the latter made in the different localities showed a low percentage of potassium as compared with other elements (0·03 – 0·06 per cent.). The experiments conducted in 1919 (in which year the month of May was exceptionally dry) showed that the addition of potassium, either by itself or in combination with other salts, greatly improved the condition of the oats and gave them a fine green colour. Previous workers have shown that lack of potassium or phosphoric acid produced stunting of the root-system and (in wheat) weakness of the straw, and that though the early development of plants growing in soils deficient in potassium may be more vigorous than the normal, later on yellow spots, gradually turning brown or greyish-white, appear between the veins of the leaves. This symptom characterized several of the plots investigated by the author during the period under review. Deficiency of potassium imparts a dingy, greyish-green colour to the grain, which ripens very slowly, and is liable to shed. It also arrests the development of flowers and fruit, and causes premature withering. These effects are not produced by a corresponding shortage of phosphoric acid or nitrogen.

Both years' experiments proved that neither fertilization with potassium alone, nor with a complete fertilizer, was able to ensure normal development of the leaves, but this was effected by the admixture of clay with the soil. The following is an analysis of the clay used in the experiments:—Water, 11·80 per cent.; phosphoric acid (P_2O_5) soluble in 20 per cent. hydrochloric acid, 0·16 per

cent. of the dry substance; potassium (K_2O) calculated the same way, 0·63 per cent. Reaction to litmus slightly acid. The clay, which apparently helps to retain the moisture in the soil and assists in the development of the root-system, should be mixed with lime only if it contains ferrous sulphide. It is stated that an addition of sand to these soils also has a good effect.

HENNING (E.). **Den växthygieniska betydelsen av lerslagning eller sandkörning av uppodlade Kärr- och Mossmarker. II. Nya försök mot gulspetssjuka, utförda 1921.** [The value of clay or sand as fertilizers for crops grown in reclaimed swamps and bogs. II. New experiments with yellow tip disease during 1921].—*Meddel. Centralanst. för försöksväsendet på jordbruksområdet*, 226, 14 pp., 3 diagr., 1 pl., 1921.

The first experiment was carried out at Rehnstad in Östergötland on bog land. The field had been ploughed in the previous autumn, and was divided into plots of 5 × 4 metres. Some of these received on 2nd May 300 gm. of 40 per cent. potash, others 600 gm. superphosphate added to the potash, while lime was added to the other two in a third set. Clay was applied two days later to some plots in the proportion of 2 hectol. per plot, either alone or in addition to the phosphate. Each treatment was applied to three plots, and there were three untreated controls. Mixed seed of Victory oats and yellow barley was sown on 14th May. All the plots, except those treated with clay, were slightly damaged by night frosts in June, but previous experiments have shown that the yellow-tip disease occurs independently of frost. The injuries inflicted by the latter are easily distinguishable from those caused by yellow-tip, as they occur chiefly at the base of the young leaves, while in yellow-tip the entire edge of the leaf is damaged at once. According to Lind, plants attacked by yellow-tip are particularly liable to frost-injury on account of malnutrition.

The best crops were obtained from the plots to which either clay alone or clay with phosphate was added. The applications of potash or potash with superphosphate were not successful, the crops being severely attacked by yellow-tip, and full of weeds. One of the untreated control plots produced a good crop with few weeds, while the other two gave very bad results. Geological and chemical analyses failed to supply any explanation of the discrepancy.

The following is the analysis of the clay used in the experiments:—Water in air-dry sample, 6·20 per cent. Soluble in 20 per cent. hydrochloric acid: phosphoric acid (P_2O_5) 0·13 per cent.; potassium (K_2O) 0·54 per cent.; lime (CaO) 0·87 per cent. (all in percentages of the dry substance). Reaction: alkaline. It is noteworthy that the admixture of phosphate led to no increase in the yield of the grain, though that of straw rose on an average by 2·4 kg. The strikingly low yield of grain, ranging from 0·9 to 1 kg., was due to poor development of the ears, possibly the result of the excessive drought. The clay evidently diminished the loss of water, thereby facilitating the formation of the ears, but was insufficient, on the decomposed peat, to promote a full development of the grain. A good fodder crop, however, was obtained by the use of clay where other fertilizers gave nothing but weeds.

The second experiment was conducted at Sickelsjö on much the same lines, in a field which had been sown with grass for two years past, while from 1916 to 1918 it bore cereal crops which were more or less destroyed by yellow-tip. Earlier tests have shown that yellow-tip is usually found immediately following root-crops rather than grass, and this was confirmed in the present experiment so that no results were obtained in regard to the disease. The plots treated with clay and clay with phosphate showed a marked tendency to lodge.

COCKAYNE (A. H.) & CUNNINGHAM (G. H.). **Lemon brown-rot and its control.**—*New Zealand Journ. of Agric.*, xxii., 5, pp. 271–274, 1921.

Lemon brown-rot (*Pythiacystis citrophthora* Sm. and Sm.), first recorded in New Zealand in 1907, appears at present to be on the increase, and a considerable amount of damage is caused by it in citrus orchards, both by the actual destruction of fruit on the tree and by the killing of laterals and even larger branches. The special conditions necessary for the production of fruiting bodies of this fungus, and its inability to cause general infection when these conditions are absent, render the disease comparatively easy to control.

In America the fungus in question has also been found on almonds, apples, cherries, peaches, and pears, but in New Zealand it seems so far to be confined to the lemon.

The disease first shows in the orchard by the appearance of small groups of dead, brown leaves, which form a conspicuous contrast to the olive-green of the healthy foliage. On the young laterals small, brown, dead areas, which remain flush with the surface of the normal cortex, are developed. The leaves on these attacked laterals turn brown and die, but remain hanging on the tree.

The first stage of infection on the fruit is a brown sunken spot, which rapidly spreads till the whole fruit is of a rusty brown colour and somewhat softer to the touch than usual. A peculiar pungent smell, characteristic of the disease, is emitted when the fruit is cut open.

Pythiacystis citrophthora is normally a soil organism living saprophytically on decaying vegetable matter, and thriving only in moist conditions. Thus no fruiting bodies are ever formed from the lesions on the branches or from those on the fruits while the latter remain on the tree. If infected fruit falls to the ground, however, and the soil is sufficiently wet, the whole fruit and surrounding soil may become covered with hyphae bearing the sporangia of the fungus. These sporangia discharge a number of zoospores which move rapidly about by the aid of two ventral cilia in drops or films of water. The zoospores are the active agents in the spread of the disease on the trees. They may either be splashed up on to the foliage with soil particles during heavy rain, or swim from place to place in the film of water which sometimes covers the leaves. After a time they settle down, lose their cilia, and, if suitably placed, germinate and produce a long hypha which penetrates the cuticle and epidermis of the leaf or fruit. Once inside, this primary hypha branches repeatedly, absorbing

the cell-contents of the internal tissues, which turn brown and die. If the lemons are packed in cases, the hyphae grow out from the infected fruit and penetrate the tissues of the healthy ones with which they come into contact. Except by this vegetative method, the fungus cannot cause further infection until it is enabled, by an excess of moisture, to develop sporangia. Every lesion on the twigs, and on the fruit while still attached to the tree, is due to infection by zoospores developed in sporangia produced either by the fungus in the soil or by fallen infected fruit. In no case can zoospores be developed on the tree itself, or on the fruit while still attached to the tree. Thus the whole object of control must be to eliminate the conditions which render sporangial development possible on the soil, or to prevent the transference of zoospores from the sporangia to the tree. The oospores of the fungus are not known.

During the summer, dryness of the surface soil may be maintained by thorough cultivation immediately beneath the tree, so as to form a dry layer two or three inches deep. Reproduction of the fungus will thus be effectually prevented. In winter, however, this dry zone cannot be maintained, and it is therefore necessary to protect the trees against infection by the zoospores. Two methods of securing this are in general use in California. The first is the cutting out of all laterals and branches in contact with the ground, and the removal of all growth which might be spattered by rain to a height of two feet above the soil. A second method is that of cover-cropping the ground during the winter. Such a crop, acting as a blanket, entirely prevents the upward carriage of zoospores by means of rain splashes. A considerable range of crops is available for this purpose, *Lotus hispidus* (or *angustissimus*) being very suitable in the Auckland and Tauranga districts. From 6 to 8 lb. of seed per acre are required, and the average cost is about ten shillings. Self-sowing usually occurs in subsequent years, so that the initial process need not be repeated. Further south, crimson clover or vetch are preferable to *Lotus hispidus* as cover-crops. King Island melilot (*Melilotus indica*) is the main cover-crop in California, but its use is not advocated in New Zealand. On reasonably fertile soil, Western Wolths ryegrass (one bushel of seed per acre) is a cheap and effective cover-crop. Emphasis is usually laid on the nitrogen-collecting character of the legumes, but the value of this feature can easily be overrated in New Zealand lemon orchards.

Pythiacystis citrophthora may occur in certain soils to a depth of three feet or more, so that soil-treatment is not practicable. Spraying the trees is also ineffectual, since the disease spreads most rapidly immediately after heavy rain, when fungicides are of little use.

Fungoid diseases attacking Lemons.—(Horticultural Division) *New Zealand Journ. of Agric.*, xxiii, 2, pp. 108–109, 1921.

Spraying tests were carried out with lime-sulphur compound and Bordeaux mixture in the Auckland groves with the object of determining the following points:—(1) The spray giving the best results; (2) the best and most economical period to apply the

same; (3) the strength at which to be applied for control of verrucosis [*Cladosporium citri* Mass.], grey scab [*Sporodesmium griseum* McAlp.], and *Pythiacystis citrophthora* Sm. and Sm. The results were as follows:—

Lime-sulphur. Strength 1–30: Will hold diseases named fairly well in check, if intelligently applied. Two sprayings in the season are ample, viz., after the blossom-petals of the main and of the autumn flowering have fallen. Weakly trees on the lighter soils will not stand this spray, and well-grown healthy trees were considerably defoliated with three applications during the season. 1–35: Results equal to 1–30. No defoliation with two sprayings in season, but slight scorching with four applications. 1–40: Almost equal to 1–35. No defoliation using four sprays. 1–50: Considerable infection always in evidence on trees sprayed at this strength. May be dispensed with as valueless for control. 1–30 followed by 1–40 (when main-crop flowers and autumn flowers respectively have fallen): Only very slight infection noticeable at any time on these trees. Very slight defoliation after 1–30 application.

Bordeaux mixture. Formula 4–4–40: An absolute control of the three diseases was maintained with two applications of this formula, after the falling of blossoms in the main crop and autumn respectively. Scorching of foliage hardly noticeable, but slight discoloration of fruit and wood. 4–4–40 followed by 5–4–40: Same periods as above. Results better than any lime-sulphur-treated trees, but not so good as two applications of 4–4–40 at the same times. 6–4–40: This was not applied at petal-falling period in these tests, and therefore a comparison cannot be made in relative value to 4–4–40 used then. Considerable scorching results from its use at any period, however, and the formula is therefore not to be recommended except for the purpose of overtaking bad infection in a very dirty grove.

It is concluded, therefore, that as a spray to combat fungous diseases attacking lemons, Bordeaux still maintains the first place. The 4-4-40 formula used at the right periods—two applications per annum—will effectively control these diseases. Except in cases of severe infection, this compound need not be used at a greater strength, and the use of 5–5–40 and 6–4–40 leads to defoliation. The excessive use of Bordeaux invariably leaves its mark upon the tree, and often on the fruit. The wood gradually becomes scorched, and the sap-cells are injured thereby; so far, however, this appears to be a necessary condition of the control of the fungus.

The fruit is of a much better appearance and the wood is less damaged by scorching when lime-sulphur is used than with Bordeaux mixture. The disease-control is not, however, so effective.

LEE (H. A.). **Citrus-canker control: a progress report of experiments.**—*Philipp. Journ. of Science*, xix, 2, pp. 129–171, 2 pl., 1921.

During the spraying experiments attempts were made to render the copper in the fungicides more readily available for action

against the canker organism [*Pseudomonas citri* Hasse]. In the case of Bordeaux mixture the excess of lime was reduced to just the amount sufficient to precipitate all the copper, while with Burgundy mixture enough sodium carbonate was added to precipitate the copper with no residue. The compounds thus obtained were known as neutral Bordeaux and neutral Burgundy mixtures respectively. Ammoniacal copper carbonate, formalin, and neutral lead arsenate were also used. A 'sticker' was employed consisting of 2 lb. of resin dissolved with heat in a solution of 1 lb. of sodium carbonate in one gallon of water. The amount used in these experiments was one quart of the 'sticker' to fifty gallons of the spray mixture. Bordeaux and Burgundy mixtures were the only sprays that were used with any degree of success, and they were not wholly effective. The amount of control obtained depended largely on the variety sprayed, and in some cases was not on an economic basis.

Other factors which materially contributed to a reduction of the disease were: (1) the use of clean-up sprays. In many cases of heavily infected trees, a spray of formalin 1–80 caused the dropping of cankered leaves on sweet orange, grape-fruit, and mandarin orange trees. This concentration, however, was too strong for limes and lemons, on which it caused too severe defoliation. Greater injury resulted from the use of this spray in rainy weather or towards nightfall, owing to the relatively slow evaporation of the formalin. (2) Stimulation of growth at climatic periods unfavourable to canker development. New growth was stimulated during the early part of the dry season, the necessary pruning having been carried out at the end of the rainy period. Thus the foliage was able to mature and harden during the dry season, when there was comparatively little danger of infection. With the recurrence of the rainy season it had acquired a considerable degree of resistance. In the case of grape-fruit and lime the results were somewhat less satisfactory than with the other varieties. (3) Control of insects. Cankers are often found along the edges of leaves bitten by chewing insects, and also in the trail of the leaf miner. Lead arsenate was frequently added to the fungicides with a view to exterminating these insects. (4) Construction of windbreaks. The wind is a powerful agent in the dissemination of citrus canker, not only by spreading the organism in the usual way, but also by wounding the twigs and foliage, and thus exposing them to penetration by the bacteria. Windbreaks consisting of dense thickets of bamboo, 10 to 15 metres in height, have proved very effective.

Wide differences exist in the degree of susceptibility to canker of the various species and varieties of citrus. Mandarin oranges, citrons (*C. medica*), calamondins (*C. mitis*), and Kumquats (*Fortunella japonica*) are very resistant, and control is almost superfluous. To the class of susceptible but easily controlled forms belong the American-grown lemons (*C. limonia*), the Mediterranean varieties of the sweet orange, the Tahiti lime (*C. aurantifolia*), and the Unshiu or Satsuma oranges (*C. nobilis* var. *unshiu*). Somewhat more difficult to control are the Florida varieties of the sweet orange, the Natsumikan of Japan, many of the pomeloes, and several strains of navel oranges. The latter exhibit a considerable range

of susceptibility. The Triumph grape-fruit also belongs to this class. Successful canker control is possible on these varieties, but it is uncertain as yet whether it is economically feasible. Lastly in the extremely susceptible West Indian lime and American grape-fruit varieties, canker control, though possible in a few cases, necessitates an extravagant use of sprays and time, and it is not economically practicable.

An attempt was made to obtain complete eradication of citrus canker by the application of strong formalin sprays and Bordeaux mixture, together with careful pruning, on a small isolated plot of calamondin, mandarin orange, and lime trees. Negative results were obtained, the canker recurring in a number of cases after all apparent sources of infection were removed. More exhaustive experiments would be necessary before this evidence could be regarded as conclusive in the case of the less susceptible varieties, though it is probably correct for the limes. In a district, such as Florida, where the extremely susceptible varieties predominate, the total exclusion of the disease, the complete eradication of all affected hosts should it appear, or the substitution of more resistant species or varieties, are apparently the only means of preventing heavy losses from citrus canker. Control of the disease, impracticable in these cases, is well worth while in areas where the less susceptible varieties are grown, in some of which, as in Alabama and Mississippi where varieties such as Satsuma predominate, it may be even unnecessary.

LYON (H. L.) & LEE (H. A.). **Citrus canker in the Hawaiian Islands.**—*Phytopath.*, xi, 9, p. 377, 1921.

The disease has been found in two orchards, one near Honolulu, and one at Kilauea. Since citrus growing is of minor importance there, eradication measures are not considered advisable.

BURGER (O. F.). **Variations in Colletotrichum gloeosporioides.**—*Journ. Agric. Res.*, xx, 9, pp. 725–736, 1 pl., 2 figs., 1921.

Wither-tip, leaf-spot, anthracnose, and tearstain of citrus plants are all caused by *C. gloeosporioides* Penzig, and have been found in Florida, California, the West Indies, South America, Australia, and Malta. The diseases appear to be worst in moist regions.

The author studied forty-six cultures of the fungus from California and other States. In culture they were found to vary as regards the colour of mycelium (white, grey, greenish, black), amount of aerial mycelium, and abundance of spores produced, but similar variations were found in successive transfers of the same isolation. There were, however, certain constant differences between the various strains in the size of the spores. The medium used affected the morphological characters of the fungus, and some of the modifications induced by prolonged culture on a particular medium were more or less persistent. In plate cultures of certain isolations, parts of the growth, usually in wedge-shaped or fan-like areas, sometimes showed mycelium of a different colour from that of the rest of the growth. These variations continued when transfers were made from the modified areas, and are regarded as mutations.

The author concludes that *C. gloeosporioides* is a polymorphic species made up of a number of strains. *Gloeosporium limetticolum* Clausen is probably one of these strains. Several strains of *C. gloeosporioides* produced the perfect stage when first isolated; this agreed with *Glomerella cingulata*.

LIPMAN (C. B.). **A contribution to our knowledge of soil relationships with Citrus chlorosis.**—*Phytopath.*, xi, 8, pp. 301–305, 1921.

Yellowing or blanching of citrus leaves was found to occur on soils with excess of calcium and magnesium carbonates (calcareous subsoils) or sodium and potassium carbonates. Such soils have a markedly alkaline reaction. The highly calcareous subsoils are mostly found underlying heavy black 'adobe' or 'dry bog' soils at a depth of from one to two feet.

Areas used formerly as sheep corrals, or sometimes areas habitually used for building camp fires, give the second type of chlorosis-inducing soils, rich in alkali carbonates and highly basic. An analysis of a 'corral' soil, and an adjacent soil on which normal citrus trees were growing, was made. The 'normal' soil had, in soil extracts, much greater total solids, non-volatile solids, volatile solids, nitrates, calcium, and magnesium than the 'corral' soil, but less phosphorus, potassium, and sodium. The iron content was about the same in the two. The explanation of chlorosis is considered probably to lie in the physiological balance of the salts in the two types of soil, as instanced by the diametrically opposite grouping of NO_3, Ca, and Mg on the one hand and P, Na, and K on the other, and the relation of magnesium and phosphorus is considered to be especially significant.

PATOUILLARD (N.). **Le Botryodiplodia theobromae sur le Cotonnier.** [*Botryodiplodia theobromae* on the Cotton plant.]—*Rev. de Bot. Appliquée*, ii, 6, pp. 41–42, 1922.

A number of cotton plants (*Gossypium punctatum*) received from Dahomey were found to be severely attacked by a fungus which the writer believes to be a local form of *Botryodiplodia theobromae*. The infected plants were stunted, the leaves being few and misshapen, and the fruit imperfectly developed, black, and remaining closed. The lint was in a shapeless agglomeration, often completely blackened, and always unfit for use. The cortex and wood of the stem and root were of an abnormal grey colour, caused by the brownish hyphae of the mycelium ramifying between the cells.

At the base of the stem, on an oval swelling several centimetres in length, small, isolated, black protuberances were found which traversed the epidermis and emerged on the exterior. They were also found, in decreased numbers, towards the upper part of the stem, and also on the larger branches and on the surface of the capsules. They were formed of a single or more commonly several black and hirsute pycnidia, with coriaceous cell-walls united by a stroma which was either compact and thick or consisted merely of fleecy hyphae. On the capsules the pycnidia were closely grouped, rounded, and with a smoother surface (sometimes quite

smooth), than those at the base of the stems which were oval and pointed at the extremity. According to the maturity of the spores, their colour varied from white to brown, and finally black. They were smooth, oval, at first continuous, hyaline, granular, and with a large central drop, then uniseptate and brown, measuring 15 to 24 by 9 to 12 μ.

The fungus is believed to be a wound parasite, and to be found throughout hot regions, occurring with slight variations on a large number of the most diverse host plants.

Pests of the Oil Palm in the Portuguese Congo.—*Bull. Imp. Inst. Gt. Britain*, xix. 2, pp. 205-206, 2 pl., 1921.

The following description of *Ganoderma lucidum* (*Fomes lucidus*) as it occurs on the oil palm (*Elaeis guineensis*) in the Portuguese Congo, is compiled from the notes of Mr. R. Swainson-Hall. The fructification appears at or near the base of the trunk, and is generally about 10 to 20 cm. thick by 20 to 30 cm. wide, forming a semicircular sconce or bracket projecting from the trunk in the horizontal plane; the under side is velvety and of an ashen-white colour, occasionally with a yellow or greenish-yellow tinge. The external surface is hard, while the inside is softer and more closely woven. The internal tissues of affected trunks become friable and emit a musty smell. The presence of the disease is first indicated by the falling over of the older whorl of leaves, though the most certain symptom is the development of the fructification which only appears after the fungus is well established. The whole of the older whorl of leaves falls away from the erect or normal position and hangs down parallel with the trunk, the centre or youngest spike being the last to fall over. A longitudinal section through the base of the trunk reveals an ashen-grey powdery mass of rotten tissue with a very musty smell. *Ganoderma lucidum* is considered to be closely related to *G. applanatum*, if not actually another form of the same species.

ZELLER (S. M.) & OWENS (C. E.). **European canker on the Pacific Slope.**—*Phytopath.*, xi, 11, pp. 464-468, 4 figs., 1921.

Since 1911, when European canker was identified on the apple in Oregon, the disease has been reported from various localities in that State and in California. Cankers due to *Nectria galligena* Bres. or its imperfect stage, *Fusarium willkommi* Lind. have now been found in this region on several apple varieties, namely Red Cheek Pippin, Bismarck, Delicious, Winter Bellflower, Spitzenburg, and Newtown; and on D'Anjou, Howell, and Bosc pears.

The concentric arrangement of callus rings in old cankers, which is such a characteristic feature of the disease in Europe and the north-eastern part of the United States, is almost or entirely absent on the Pacific slope. Possibly on account of climatic conditions, the cankers spread very rapidly, extending from several inches to one or two feet in a single season, and remain more or less closed. Infections appear to take place chiefly at small, sappy, pruning cuts, or in the crotches of large branches or of the fruiting or leaf spurs. Sun scald, winter injury, or other physiological disturbances assist infection.

The fungus sometimes starts in the periphery of cankers produced by *Neofabraea malicorticis* on the D'Anjou pear. In many cases of winter injury both to Bosc and D'Anjou pears, *Nectria cinnabarina* (Tode) Fr., which appears to exist as a parasite at least on partially devitalized wood, also gains a foothold.

In Oregon the cankers on D'Anjou pear have been observed early in June, mostly as a result of infection the same spring. The stromatic cushions bearing macro- or micro-conidia first appear very near the seat of infection, but, as the canker increases in size, new ones develop further out. The perithecia develop later in these conidial pustules. The duration of the conidial stage is from the early spring to October at least.

In the early stages of the canker, especially on pear, the raised portions of the bark have a spongy, oedematous character. This condition is succeeded by an irregular peeling off of the epidermis. The exposed portions of the cortex are black and moist. As the cankers grow older, the diseased bark becomes cracked and furrowed, sometimes irregularly, but often on more or less concentric lines. These concentric fissures probably represent a periodicity of growth of the fungus due to atmospheric changes, and must not be confused with the concentric annual growths characteristic of the open type of canker found in other regions.

RANKIN (W. H.) & HOCKEY (J. F.). **Mosaic and leaf curl of the cultivated Raspberry.**—*Canada Dept. of Agric., Division of Bot. Circ.* 1, new ser., 3 pp., 1922.

The two diseases of the cultivated red raspberry here dealt with have been in the past both included under the name 'yellows'. Recent work has shown them to be distinct. They have been reported at various times as a cause of serious loss in different parts of North America, and mosaic has increased in the Niagara district during the past two years, until it is now epidemic, an average of 20 to 30 per cent. of the commonly cultivated Cuthbert variety being affected. The few plantations of the variety Marlboro are even more severely attacked. The Herbert raspberry, on the other hand, is only slightly affected (1 to 3 per cent.) except when grown adjacent to the other two. Since the diseased bushes never recover, the position is serious.

Mosaic can be recognized, even from a distance, by the dwarfing of the canes, the sparse yellow foliage, and thin growth. The leaf symptoms are best seen on the current year's suckers, on which, before the middle of June, the leaves show large, irregular, green blisters which arch upwards, the tissue between the blisters being yellowish. Later on the top leaves show a fine, yellow, speckled mottling. Leaves put out during very hot weather do not show symptoms. On the fruiting canes the leaves are only about half the normal size and show the green blisters or yellow speckling. The fruit is worthless on bushes diseased for more than a year, being dry and tasteless. Spread takes place chiefly along the rows, not missing any bushes.

Plants with leaf-curl are marked by bearing leaves on both first and second year canes that are darker green than normal and have the midrib bent downwards throughout its length. A similar bending

of the main lateral veins causes a downward curling of the whole of the leaf margin. The tissue between the veins arches upwards and is crimped along the veins. The fruiting laterals are short and upright, and the suckers, after the bush has been diseased for a year or two, are dwarfed and usually end in a yellow, stunted top. The fruit is dry and seedy and should not be picked. As the affected bushes are worthless they are usually dug out early and the average incidence of the disease (from 2 to 6 per cent. in the Cuthberts) noted in 1921 in the Niagara area represents only the annual loss. The Marlboros and Herberts are rarely attacked.

Both diseases are infectious and are spread by the same agent, the small plant louse *Aphis rubiphila*. The variety Herbert is believed to be avoided by these insects ordinarily, though they will pass to it when it grows near the others. This is believed to be the reason why it usually escapes when grown alone. Infection is not spread by the pruning or cultivating implements, and new plants may be safely set in spaces from which diseased ones were removed. The aphid is believed to be the only agent of spread.

For control it is recommended to plant only disease-free stock and to remove all diseased plants at the time of year when spread does not take place (i.e. when the aphids are not active). It is not believed that the aphids can travel far, as no winged stage has been found. Varieties possessing true immunity are apparently not known as yet.

PROTZEN (K.). **Die Krebsfrage in physiologischer Beleuchtung.** [The canker problem from a physiological aspect.]—*Deutsche Obstbauzeit.*, lxviii, 6–7, pp. 62–63, 1922.

The author states that investigations during a number of years indicate that canker in apple-trees is constantly associated with water-logged acid soils, and soils rich in nitrogen and deficient in minerals, while it is infrequent on moderately fertile, non-acid, permeable sandy and clay soils. It is invariably prevalent where the subsoil consists of pyrites or peat. Certain varieties of apple have a hereditary predisposition to the disease.

Two trees of a susceptible variety were planted close together in marshy soil with a peat subsoil, building refuse and lime being mixed with the soil round one. In three years the latter was a fine tree with excellent fruit and free from canker, while the other was literally covered with cankers. A low-lying apple orchard periodically flooded with the albuminous lye from a starch factory had all the trees cankerous from the nitric acid developed in the soil. The same was the case in several orchards on sandy soil flooded with ditchwater, where the subsoil contained sulphate of iron, the acid in this case being sulphuric.

The acid is believed to act chiefly on the medullary rays, which are weakened and unable to stand the effects of frost and other destructive agencies. The *Nectria* associated with canker is believed to be a purely secondary occurrence.

Susceptible varieties are stated to include Golden Pearmain, Landsberger, and Bellefleur, while Gravenstein, Boskoop, and Grey Reinette are seldom attacked even on 'canker soils'.

PEYRONEL (B.). **Una grave malattia del Mandorlo prodotta dal Fusicladium amygdali Ducomet.** [A serious disease of the Almond produced by *Fusicladium amygdali* Ducomet.]—*Nuovi Ann. Minis. Agricoltura*, i, pp. 27–44, 7 figs., 1921.

The author reports a serious disease of almond trees, observed at Rome in 1919. It is caused by a fungus identified as *Fusicladium amygdali* Ducomet (*Ann. École Nat. d'Agric. Rennes*, iv, 1910).

The symptoms are a more or less heavy defoliation, especially of the lower branches, combined with dropping of the blossoms and young fruit in the spring. By the beginning of October the affected trees were almost bare of leaves and many of the twigs were dead. The parasite overwinters on the branches and attacks the buds and new shoots in the spring, but does not make much progress until these and the leaves have reached a certain stage of development. The blossoms and fruits are not directly attacked, their dropping being apparently due to lowered vitality of the bearing twigs with, in some cases, infection of the fruit stalks. The older branches and those of trees fully exposed to the sun were more resistant to attack than younger ones or the succulent branches of shaded trees.

The disease on the leaves appears in the form of small rounded or sub-polygonal spots, covered with a velvety olivaceous conidial efflorescence, on the underside, the upper surface being less often and less markedly spotted. The spots progress, especially on the larger fleshy leaves of the younger shoots and in shaded parts, until they may cover the whole surface of the leaf, which then dies and falls off. On the smaller, tougher leaves of older shoots and those exposed to the sun, the spots may remain minute, without coalescing, and gradually turn reddish and dry up. Though surface extension is checked in these cases, the mycelium penetrates through the thickness of the leaf and causes a spot on the corresponding part of the upper surface. Ultimately the diseased area is cut off and falls out, leaving a perforation similar to the 'shot hole' caused by *Clasterosporium carpophilum*, but not leading to much defoliation.

On the branches the spots are chiefly on the lower shaded surface especially near the buds. On young, succulent parts they are dark green, later becoming pale and oily in appearance and then brown and with raised crusts which may extend over large patches. On older and exposed branches the spots are reddish from the development of anthocyanin, later becoming brown and crusty as a result of the formation of wound cork in the sub-epidermal tissues. The centre of the spots may ultimately become depressed from drying up and collapse of the tissues. The olivaceous efflorescence formed by the conidial fructification is found on young branches, on shady parts, and at the periphery of the old crusts. It may be absent, but usually forms freely in moist weather on the succulent shady parts. Many of the affected branches wither, drying up from the tip backwards.

The fungus is a sub-cuticular parasite in the earlier stages of its development both on the leaves and branches, remaining confined to the cuticle, or between the latter and the cellulose part of the outer epidermal wall. It only penetrates the underlying tissues after their death. The sub-epidermal cells are killed in advance of

penetration, but whether by drying out or by the diffusion of a toxin was not ascertained. On the branches a layer of cork is formed in the cortex, which is most strongly developed in the older or more exposed parts; in young succulent shoots it is thin (though often very extensive), or may even be absent, the walls merely becoming suberized in this case. The mycelium ultimately penetrates the hypodermal layer, at first between the cells, but after their death within them. Penetration is most marked in the upper angle of the buds. The bud scales are also filled with mycelium, and pycnidia were found in this locality, though the author is not able to say definitely that they belong to the same fungus. Small, sub-cuticular stromatic aggregations of mycelium are often found, especially on the branches.

The dendritic mycelium of the sub-cuticular stage is hyaline and thin-walled at first, then turns brownish and thick-walled as the cuticle is destroyed. The deeper mycelium also turns brown after the cells are killed. Conidia are formed in a manner similar to those of *Fusicladium pirinum*, on olive-brown erect conidiophores, which may be forked above and frequently show knee-bends where the earlier conidia were inserted. The conidiophores are up to 120 μ long by 4 to 7 μ broad, with 1 to 3 septa, and numerous papillae towards the tip marking the points of insertion of the conidia. The latter are variable in form, often piriform, clavate, or fusiform, apiculate, and slightly narrowed in the middle where there is sometimes a transverse septum. Before germination most of the unicellular conidia become septate at this point, a second septum also occasionally developing. They are most frequently 15 to 20 by 4·5 to 5·5 μ in diameter.

The fungus is considered to be xerophilous and very closely related to *Fusicladium cerasi* and *F. pruni*, with which it is perhaps morphologically identical though differing in its parasitic properties. The author is inclined to doubt whether differences in infective capacity on different hosts form a good ground for separating species.

Treatment on the same lines as commonly practised against apple and pear scab is believed by the author to be likely to be effective in controlling the disease, though he has not had an opportunity of testing it experimentally. Snails are said to play a part in disseminating the conidia, which survive passage through the alimentary canal and germinate freely in the excreta.

DUFRÉNOY (J.). **Les maladies du Melon.** [Diseases of the Melon.] —*Ann. des Épiphyties*, vii, pp. 405–420, 16 figs., 1921.

A serious disease of melons in the south-west and south-east of France is described in detail. It appears to be due to a double infection by a *Fusarium*, which the author identifies as *F. solani* (Mart. p.p.) var. *cyanum*, subvar. ?, and a motile Bacterium not identified. The latter is present from the commencement of the lesions and always precedes the infection by *Fusarium*, which is believed to be of a secondary nature. The morphological and cultural characters of the fungus are fully described.

The disease causes a collar rot and a wilt, the latter being the result of a cankerous necrosis of the underground parts of the

plant, and therefore not a true vascular wilt. The aerial parts are said to be affected by toxic action at a distance from the seat of infection, and take an oily translucent appearance, distinct from that induced by drought. No evidence is detailed establishing the existence of this toxin.

Infection occurs through the rootlets, usually at the tip, which rots, dries up, and turns brown, or through lesions caused in the roots by the destruction of lateral rootlets. The browned vascular tissue of infected roots can be traced to the collar or even higher up the stem, lateral spread of infection taking place to a lesser extent. Above the limit at which the mycelium of the *Fusarium* can be detected in the vessels the brown colour is still present, the walls of the tracheids and neighbouring cells being delignified, thickened, granular, and suberized. There is an abundant development of tyloses, and numerous bacteria are found in these and in the lumina of the vessels. The wood parenchyma is filled with a yellow gum, and the cortex and medullary rays in the vicinity react by the production of a layer of cork which tends to isolate the infected area.

The common variety, Cantaloup de Bellegarde, is the most susceptible to this disease, which the author thinks can be best combated by the selection of resistant strains. Attacked plants should be pulled out and destroyed, contamination by the accidental transport of infected soil or implements from diseased to healthy fields avoided, and a long rotation practised.

Other bacterial diseases of melons, including one which resembles the wilt caused by *Bacillus tracheiphilus*, not hitherto reported in France, are briefly referred to.

ROBERTS (J. W.). **Plum blotch, a disease of the Japanese Plum, caused by Phyllosticta congesta Heald & Wolf.**—*Journ. Agric. Res.*, xxii, 7, pp. 365–379, 1 pl., 1921.

Plum blotch has been present in Georgia since at least 1905 on the Japanese plum (*Prunus triflora*), but the causal organism, *Phyllosticta congesta*, was first described by Heald and Wolf on the leaves of *Prunus* sp. in Texas in 1911. Lack of demand, coupled with the great susceptibility of the Japanese plum to diseases and pests, have led southern growers, particularly in Georgia, to abandon its cultivation, but should this be revived, the writer thinks that the disease under discussion will prove a formidable obstacle, as it is very destructive and its control would most likely present serious difficulties. The varieties affected were Abundance, Burbank, and an unnamed seedling. Not only the fruit, but the leaves and possibly also the twigs, were attacked, the lesions produced by the parasite greatly resembling those of apple blotch caused by *P. solitaria* E. and E. The fruit was rendered almost worthless, being marked when unripe with raised dark-coloured areas, roughened by small blisters and depressions, and when ripe, with irregular brown patches consisting of an aggregation of from four to twenty small sunken spots. The affected tissues become hardened and leathery but do not decay. Small spots are also found on the leaves, sometimes as many as 200 on a single leaf. On the twigs there are small, light-coloured, sunken areas, but the pycnidia found

here were empty, so that a positive identification could not be made. Elsewhere the spots bore numerous ripe pycnidia, those on the leaves being usually single in each spot. Morphologically the fungus is similar to *P. solitaria*. It is not known how it is carried over from one season to another but it is thought probable that it may winter on the twigs and possibly also on the leaves and fruits.

Notwithstanding the similarity existing between *P. congesta* and *P. solitaria*, the writer prefers to keep them separate, the more so as his repeated attempts to inoculate plums with *P. solitaria* failed. On the other hand, spores obtained from cultures of the plum fungus on sterile apple twigs applied to healthy plum fruits and leaves produced characteristic lesions of the disease.

No attempts have been made to control plum blotch, but in view of the injury to the fruit of the Japanese plum caused by effective solutions of fungicides, the writer foresees considerable difficulties in this direction.

GÄUMANN (E.). **Over een bacterielle vaatbundel ziekte der Bananen in Nederlandsch-Indie.** [On a vascular bacterial disease of the Banana in the Dutch East Indies.]—*Meded. Inst. voor Plantenziekten*, 48, 134 pp., 8 pl., 18 figs., 1921. [English summary.]

The most important banana diseases may be divided into three groups. (1) The Philippine bacterial disease; (2) the Pusa disease; and (3) diseases of the Panama type. In the last-named group must be included a disease first observed in Java in 1915, and named the Java vascular disease. Although nearly all the bananas grown in Java are attacked, no external change is apparent in 90 per cent. of the affected plants. In cases of extreme susceptibility, however, there are certain irregularities in the external development of the plant, especially partial or total arrest of the growth of the heart leaf, longitudinal splitting of the outer leaf-sheaths, and premature wilting of the crown. The internal symptoms are the discoloration and death of the vascular bundles of the rhizomes, and, in severe cases, also of those of the aerial parts. In some varieties the cell-sap exuded from these vessels is red in colour. Neither the external nor the internal symptoms are peculiar to the Javanese disease, the former resembling those caused by several other parasites, and the latter agreeing with those of the Panama disease.

Experiments have shown that the vascular bundles of absolutely healthy plants are practically free from organisms. Amongst cultivated bananas this was only observed in some plants of Pisang Radja that had been grown from seed. With relatively healthy plants, in which discoloured bundles occur in the root stock but not in the aerial parts, various organisms, especially bacteria and spores of species of *Fusarium*, are carried upwards by the sap stream. Furthermore, it is not uncommon to find local vascular lesions of relatively small extent both in the root stock and in the aerial parts, usually the result of external wounds. The organisms that were found in these local vascular lesions were shown to be incapable of producing disease in sound tissue. Of those found in lesions

of greater extent, often extending from the rhizome up into the stem and sheaths, six species of *Fusarium* were isolated, which represent only a selection from the mass of strains of *Fusarium* occurring in the discoloured vascular bundles in different localities. This *Fusarium* flora is not uniform throughout the Archipelago; neither can any one species be demonstrated as constantly as *F. cubense* in the West Indies. Inoculation experiments with the isolated strains gave negative results, the *Fusaria* being unable either to grow into or discolour the healthy bundles. They are therefore not pathogenic, and none of the strains thus obtained can be considered identical with the *Fusarium* of the Panama disease. *Oedocephalum spinulosum* n. sp. was twice isolated from severely diseased rhizomes, and a Chytridiaceous fungus with sporangia and zoospores was found in the vessels, mingled with bacteria. The latter is doubtfully referred to the genus *Pseudolpidum* as (?) *Ps. musicolum* n. sp. Experimental evidence was obtained that these two fungi, of which a Latin diagnosis is given and the first is figured, are non-parasitic. Eight different species of bacteria were also isolated, of which only one, which is provisionally named *Pseudomonas musae* n. sp., was able to produce the characteristic vascular discoloration when inoculated through borings into the rhizome, aerial stem, and leaves, and is regarded as the cause of the disease. The successful inoculations were made in part on plants of Pisang Radja raised from seed. In the rhizome inoculations, the discoloration of the vessels was found to have extended 6 cm. or more in five days, while from those in the stem and leaf nerves it reached 40 cm. in the same time. The bacillus was re-isolated from the diseased vascular bundles. The injection of larger quantities of this organism, the morphology and physiology of which are very fully described, produced the typical external symptoms referred to above. Twelve plants were inoculated by boring the rhizomes, of which the seven that remained (five were lost by accident) were found a year later to be stunted, thin, and without suckers, except in two cases. One was dead and one had the stem split. The other plants in the field were healthy and had fruited. The discoloration of the vessels was confined to the rhizome in the still living plants. Further experiments showed that other genera of the Musaceae were susceptible to infection by *Ps. musae*, various species of *Ravenala*, *Strelitzia*, and perhaps also *Helicoma*, having been successfully inoculated.

The symptoms and pathological tissue changes in diseased plants are stated to be in part the result of secondary organisms that follow the primary cause of the disease. The latter brings about a discoloration and breaking down of the vessels. The mixed bacterial flora that follows extends this destruction and causes the invasion of the neighbouring cells. A copious formation of gum takes place, completely stopping the sap channels. *Fusarium* hyphae penetrate soon after the bacteria and grow up through the vessels and other cells of the bundles, completing their destruction.

The disease is disseminated chiefly by the planting of infected suckers, and possibly also by the cutting-knife, as in the gum-disease of sugar-cane. *Ps. musae* was isolated from the soil, which must therefore be regarded as a possible source of infection. All

varieties seem equally susceptible, though in the case of *Musa textilis* the progress of the disease is less rapid. In West Java certain varieties, such as Pisang Radja and Radja-Sereh, are more liable than others, but this was not found to be the case elsewhere and may possibly be due to climatic conditions.

Control measures do not seem to have much prospect of success. The use for propagation of very young suckers before they have time to be penetrated by the parasite is recommended, the cut surfaces being treated with a disinfectant before planting. Subsequent infection through the root-system, however, may occur. The breeding of immune or resistant varieties is excluded, owing to the uniform susceptibility to the disease of all the Java varieties. The importation of banana rhizomes from America is considered undesirable.

The author does not consider that *Fusarium cubense* has been conclusively proved to be the cause of the Panama disease. He believes that the action of this fungus is similar to that of the species of *Fusarium* associated with the Javanese disease, and that in all probability it should be regarded only as a secondary factor in the causation of the disease. Owing to its toxic activity, however, the effects of *F. cubense* are more severe than those of the species found in Java and distinguish the genuine destructive Panama disease from the milder forms of wilt described above. Almost all those who have studied the Panama disease report the presence of bacteria in the vessels of diseased plants, and the author believes that the primary cause of both diseases will be found to be a bacillus, though he does not suggest that the same species is necessarily concerned. Other diseases of the same type for which a similar origin is suggested are those described by Basu in India, by Hori in Japan (Bonin Islands), and by various writers in Australia. Bunchy top [see this *Review*, i, 4, p. 108] seems to be included in these.

GÄUMANN (E.). **Onderzoekingen over de bloedziekte der Bananen op Celebes I.** [Investigations into the blood disease of Bananas on Celebes Island.]—*Meded. Inst. voor Plantenziekten*, 50, 47 pp., 8 pl., 1921. [English summary.]

For some years an extremely serious disease of bananas has been prevalent in Celebes and a neighbouring small island. The symptoms of this disease (which the natives have named 'blood' disease), are apt to be confused with those of the much less harmful Javanese vascular disease [see last abstract] which is common in the same area, as elsewhere throughout the Dutch East Indies. The blood disease, which is at present restricted to the localities mentioned, presents two distinct groups of characteristic symptoms, which involve the leaf crown and the fructification respectively.

The visible effects on the leaf crown are relatively late in appearing, usually after the fruit stalk comes out. First one of the younger leaves, generally the third or fourth from the youngest, begins to show discoloration, broad, light yellowish-brown stripes extending from the midrib towards the margin of the leaf. This condition may persist for some time without apparently affecting the rest of the leaf crown or the development of the fruit. Then

suddenly the whole crown turns yellow, the leaves fall over, and the curious appearance is presented of a more or less green fruit stalk hanging down out of a withered crown. Only in one case has the writer known discoloration of the leaves to occur in young plants. In the fruits also the symptoms develop late, usually at the beginning of ripening, the fruit clusters up to that time being quite normal. They then turn yellow or brown, especially on the side touching other fruit in the bunch, become marked with darker spots, and appear exactly as though they had been baked. Finally they collapse and decay.

In the rhizomes and stem the disease causes similar changes to those produced by the Javanese vascular disease, especially as the reddened slime may also be found at times in the latter. The alterations in the fruits, however, are peculiar to the present affection. A yellow or brown discoloration of the central vascular bundles first occurs. This is not unlike the condition produced in the fruits in very severe cases of the other disease, but whereas in the latter no further extension takes place, the discoloration in blood disease extends into the placentae and parenchyma, and even to the bundles of the fruit rind. All the diseased bundles are filled with bacterial slime. The entire fruit then turns yellow, and its flesh is gradually dissolved. The cavity thus formed is filled to the base of the fruit with a slimy, brownish-red fluid containing innumerable bacteria. The fruits finally collapse and decay into a rotten mass. This fruit rot is absolutely characteristic of the blood disease.

In contrast to the Javanese disease, where the symptoms are produced by the more or less mechanical interference with the food supply, resulting from blocking of the vessels, the changes in the leaf crown in the blood disease seem to be due more to some physiological disturbance. The vascular interference is much less extensive in this disease than in the other, and is insufficient to account for the symptoms, which the author thinks are more likely due to the action of a toxic substance carried into the green parts from bacterial infection lower down. The symptoms first become strongly marked at the time when the physiological processes of the plant are especially active, namely, when the fruit stalk is formed and a great quantity of food material is being transferred from the rhizome to the developing fruits.

The inoculation experiments carried out were for the most part made with pieces of diseased tissue or some of the bacterial slime, without isolation of the specific organism. They were directed to establishing the presence of a pathogenic organism in the rhizome, discoloured bundles of the false stem, diseased tissue of the fruit, and in the reddish-brown liquid that ultimately fills the fruits; and to reproducing the symptoms of the disease by inoculations from these parts. From the rhizomes the results were somewhat contradictory, though the author is satisfied that the organism is present there, and can reproduce the disease if inoculated into rhizomes, false stem, and fruit. From small pieces of the discoloured vessels of the false stem infection was obtained with complete success on false stems and fruit, but was irregular on the rhizomes. Pieces of the yellowed parenchyma of diseased fruit

and also the liquid in rotted fruits in the last stages of the disease were fully infectious on fruits and false stems of healthy plants, while the former caused some discoloration of the vessels in the rhizome, but none was produced by the liquid. Infections from yellowish fruit were found to cause the withering of the whole crown when made in the false stem, and to spread to the fruits when made in the axis of the fruit cluster.

Isolations were made of the organisms present in rotting fruits, by first inserting some of the liquid into sound fruits, and then making isolations from the margin of the resulting discoloration. Of the various bacteria that developed only one, a yellowish bacterium which will be fully described later, was found capable of reproducing the disease. Work with this organism is still incomplete.

The disease appears to be endemic in the whole of South Celebes. Not only is infection transmitted by the use of suckers from diseased plants, but experiments indicate that it is capable of independent life in the soil. Soil likely to be contaminated was used to inoculate healthy fruits and gave rise to the disease in some cases. Furthermore, evidence was obtained that it can be disseminated through the air, and the direct application of the bacterial slime from rotted fruits to the stamens during flowering caused infection of the fruits through the style to appear about a month later. It is possible that insects may play a part in disseminating the disease in this manner, especially as cases of natural infection of this type have been observed.

The author believes that there is no connexion between the two banana diseases on which he has worked, though in Celebes both may co-exist. His observations and experiments have convinced him that the blood disease is not a secondary infection superimposed on the common Javanese disease, and this should greatly simplify the question of its control.

Attempts to deal with it by the selection of resistant varieties have not given satisfactory results. Over one hundred varieties, indigenous and imported, were kept under observation from 1918 to 1920, but in the end they were all found to be diseased. The question of degree of varietal susceptibility has not yet been studied. On the first appearance of the disease the affected plants should be cut down and the rhizomes grubbed out, and piled in heaps on which lime should be placed. Burning them is difficult and slow. The natives sometimes dig deep trenches in infected fields, and fill them with lime before replanting. The rhizomes used for planting are then placed in a mixture of water and wood ash for a quarter of an hour, after which they are placed in the trenches and again plentifully fertilized with wood ash. Another measure frequently adopted on the first signs of discoloration is to cut away the suckers and then to dig a trench round the base of the affected plant, filling it with a thick layer of ash. The plants are said to bear good fruit as a result of this treatment, which probably acts by supplying a potash fertilizer at the critical stage of the disease. Until further work on the control of the disease has been carried out the author recommends the prohibition of the export of propagative stock and of fruits from the areas in which the disease occurs.

PRITCHARD (F. J.) & PORTE (W. S.). **Use of copper soap dust as a fungicide.**—*Phytopath.*, xi, 6, pp. 229–235, 1921.

The dust was made as follows: 'A hot aqueous solution of resin fish-oil soap or potash fish-oil soap solution of about the consistency of syrup was poured into a saturated solution of copper sulphate and stirred to bring all the soap into contact with the copper. The soap solution was made just thin enough to cause a chemical reaction with the copper sulphate.' The mixture was kept hot until the reaction was completed. The precipitate of copper salts of fatty acids was dried in the air and ground to a powder. Copper soap dusts containing crystalline copper sulphate and soap in the proportion of 1 to 4 and 1 to 6, respectively, by weight, were thus prepared. Lead arsenate at the rate of 2 lb. to 1 lb. of crystalline copper sulphate, and calcium arsenate at the rate of ½ lb. to 1 lb. crystalline copper sulphate were used in certain dusts. These dusts were tried under field conditions in 1919 and 1920, in comparison with copper soap liquid, Bordeaux mixture, and Sanders' copper-lime dust on tomatoes for the control of *Septoria lycopersici*. Good results were obtained in these tests from the copper soap dust, which has for two years at the Arlington experimental farm given as good control of tomato leaf-spot as 4–4–50 liquid Bordeaux mixture. It spreads, floats, and adheres better than Sanders' Bordeaux dust. It is cheaper than Bordeaux spray, considering the cost of application. The 1 to 4 and 1 to 6 copper soap dusts appeared to be equally effective.

MACCIONI (M.). **La pasta Caffaro e il supersolfo nella lotta contro l'Exoascus deformans.** [Caffaro paste and super-sulphur as means of combating *Exoascus deformans*].—*Bull. R. Soc. Toscana di Orticultura*, xlvii, 1–2, pp. 7–9, 1922.

In February 1921, experiments were carried out at the College of Pomology in Florence to ascertain the effects on *Exoascus deformans* of super-sulphur (4 per cent.) and Caffaro paste (2 per cent.). [See this *Review*, i, 3, pp. 66–67.] The results were that, though the disease was not entirely prevented, its incidence was greatly reduced by each of the fungicides, especially after two applications. The development of the fungus was checked, and the affected trees were able to put out fresh shoots. The untreated controls were unable to ripen their fruit owing to the heavy damage caused to their foliage by the disease.

WÄHLING (G.). **'Solbar' und 'flüssiger Schwefel' zur Bekämpfung des Apfelmeltaues, des amerikanischen Stachelbeermeltaues, usw.** ['Solbar' and 'liquid-sulphur' for the control of apple mildew, American gooseberry mildew, &c.].—*Deutsche Obstbauzeit.*, lxviii, 3, pp. 31–32, 1922.

The writer records successful results with both these preparations in experiments carried out for the Hanover Chamber of Agriculture. The apple mildew was in a virulent form in consequence of the hot weather, but was readily checked when taken in time, though it is noted that neglect of immediate spraying when the first signs of mildew appear greatly increases the difficulty of control. The most susceptible varieties are stated to be those

with broad light-coloured or narrow grey-green leaves, especially the latter. But under the conditions of the season, even the normally very resistant Charlamowski variety was severely affected.

Pear scab (*Fusicladium*) was checked, and gooseberry mildew completely eliminated, by these preparations, repeated sprayings being given in the latter case as soon as the shoots were 15 to 20 cm. in length. One application was sufficient after flowering. Winter spraying is also necessary in this disease. Both disinfectants also proved extremely valuable in the control of club-root of cabbage. Though the plants were in such a condition that an improvement was scarcely to be expected, the application resulted in their gradual recovery and subsequent luxurious growth.

The writer strongly recommends the use of liquid in preference to powdered sulphur, as being cheaper, simpler, and more effective in consequence of its more equal distribution. 'Solbar' and 'liquid sulphur' are equally effective, but the latter is easier to manipulate and better in practice.

SEVERIN (H. H. P.). **Minimum incubation periods of causative agent of curly leaf in Beet leaf-hopper and Sugar Beet.**—*Phytopath.*, xi, 10, pp. 424–429, 4 figs., 1921.

Curly leaf is not transmitted by seeds from infected plants; 22,738 such seeds have been planted without a case of the disease developing. The beet leaf-hopper (*Eutettix tenella*), the only known carrier of the disease, is not infective when it first hatches from the egg, and it is therefore possible to carry out experiments with insects that are known to be free from infection.

The leaf-hoppers do not merely mechanically transfer the pathogenic factor; this fact was noted by Smith and Boncquet, and confirmed by the author in the following experiment. Non-infective nymphs were allowed to feed one to two minutes on a diseased leaf, then transferred at once singly to healthy plants, and allowed to feed for five minutes or less. This experiment was repeated forty-four times, but in no case did the healthy plant become diseased. Twenty-three of the nymphs, after feeding as above, were placed in a cage with a healthy beet; it remained healthy at the end of forty days; the twenty-one remaining nymphs were put in another cage with a second healthy beet, which became diseased, showing that the leaf-hoppers may sometimes become infective after a time, from feeding for one or two minutes on an infected beet. That infection of healthy beets by the leaf-hoppers is not a mechanical mass-infection phenomenon was demonstrated by allowing nymphs to feed for five minutes on diseased leaves, then transferring three nymphs to each leaf of a healthy plant for ten minutes, using thus six to twenty-one nymphs per plant: twelve beet seedlings so treated remained healthy. The 131 nymphs thus used were then divided among six cages, each containing a healthy plant; in only one of these cases was curly leaf developed, thus showing that though the leaf-hopper can become infective subsequently, after feeding five minutes on diseased plants, this is by no means a regular occurrence.

Tests were made in order to determine the minimum length of time required for leaf-hoppers to become infective after feeding

on a diseased plant. This was found to be four hours at an average temperature of 100° F. (max. 103°, min. 94°). At lower temperatures more time was required, and negative results were obtained even after forty-eight hours at an average temperature of 67° to 73° F., but other factors (latent condition of disease-producing agent ?) than temperature may operate.

The minimum incubation period of the causative agent of curly leaf in the sugar beet, as judged by the length of time after inoculation required to cause the plant to become capable of infecting leaf-hoppers that fed on it, was found to be five days at an average temperature of 72·8° F. The leaf-hoppers feeding on beets may become infective as much as two days before visible symptoms of curly leaf appears on the plants on which they feed. Infected nymphs do not lose their infectiveness during moulting.

ROBBINS (W. W.). **Mosaic disease of Sugar Beets.**—*Phytopath.*, xi, 9, pp. 349–365, 1921.

This disease was found in increasing amount in Colorado during the years 1917 to 1920, and is distinct from curly-top which is rare in this region. The symptoms are fully discussed, the most characteristic being the mottling of the leaves, usually with some malformation (puckering of the mesophyll, bending back of the leaf near the tip, cessation of growth, and curling of the leaf margins), especially when the plants are grown in the greenhouse. Knot-like swellings on the veins and protuberances on the leaves, characteristic of curly-top, are not found in mosaic. Vascular and other adjoining tissues of affected plants show a pathologic condition resembling the phloem necrosis recorded for potato plants. Many of the phloem elements are filled with a brown substance and their walls are darkened and thickened. Starch transportation in the leaves is impeded. Plants sometimes lose the mosaic appearance later in the season, but probably still have the disease, for their roots when planted out give shoots bearing mosaic symptoms on their first leaves.

A number of observations and experiments are recorded which demonstrate that aphids (*Myzus persicae*) carry the infectious principle from plant to plant. The period of incubation was found to be from twelve to twenty-four days. Attempts to transfer the disease artificially by needle inoculations, injection of juice, and insertion of crushed mosaic leaves into slits in the leaf petioles and crown were unsuccessful. No evidence of seed transmission was obtained. The virus retains its vitality in beet roots, topped and held over winter to be planted out for the production of seed for the following season. This is the only method of over-wintering thus far known.

This is believed to be the first time mosaic has been reported on sugar beet, though other varieties of beet are affected in Europe.

MAGROU (J.). **Symbiose et tubérisation.** [Symbiosis and tuberization.]—*Ann. Sc. Nat.*, sér. x, iii, 4, pp. 181–275, 9 pl., 9 figs., 1921.

The author undertook the present work with a view to verifying

whether Noël Bernard's hypothesis of the fungal origin of tuberization, demonstrated by him to be true in the orchids, could be established experimentally in other groups, more particularly in the potato (*Solanum tuberosum*) and *Orobus tuberosus*. The former presented the difficulty that in the course of long centuries of careful selection and cultivation it has become a highly domesticated plant, living in conditions very different from those of its natural habitat, and has lost the fungal symbiosis which is the rule for wild tuberous plants and which exists in the case of the Chilian wild potato (*Solanum maglia*), and of other perennial Solanaceae such as the nightshade (*S. dulcamara*). In order to study the part played by symbiosis in the development of the cultivated potato, the author sought, therefore, to restore the plant to its original normal conditions of existence in the presence of its former symbiont. For this purpose he sowed potato seeds in an uncultivated piece of waste land, under some bushes of nightshade in the roots of which the specific symbiotic fungus had been found to be present. On examining the plants raised from these seeds a few weeks later he found their roots to be invaded by a fungus identical with the normal symbiont of *Solanum maglia* and *S. dulcamara*. The plants grew further in two quite distinct ways: in some, the secondary shoots growing from the base of the main stem developed either into leafy aerial stems or into long underground stolons which never formed tubers; while in the others the secondary shoots developed into short stolons thickened into tubers behind their terminal bud. The microscopic examination of serial sections of the roots showed that each of these types of growth corresponded to a different reaction of the plant to the invading organism. In the tuber-producing plants the roots were widely invaded by a living mycelium, having the distinctive features of that of an endotropic mycorrhiza, showing that in this case a symbiosis had been established between the fungus and its host. In the plants without tubers, on the other hand, the fungus had also penetrated some cells of the roots, but had been rapidly digested by them. The invaded areas contained the fungus in a state of complete degeneration, and the invasion had evidently been very restricted in extent and duration.

The experiments showed that, under identical conditions, tuberization of the potato plant took place only when the latter had adapted itself to a state of symbiosis with the specific endophyte, and that in a poor soil and in conditions nearly the same as those under which wild plants grow in nature, symbiosis can be a decisive factor in the production of tubers.

Investigations carried out with *Orobus tuberosus*, the roots of which normally harbour a symbiotic fungus, gave similar results. Seedlings of this species grown under aseptic conditions in nutrient agar did not produce tubers, and their basal buds gave rise to leafy aerial stems, while in seedlings cultivated in soil in the presence of their specific symbiotic fungus, the differentiation of the basal buds was inhibited at an early stage, and they formed into tubers; microscopical examination showed that in this case the roots were invaded by the fungus and that symbiosis was established. In an annual species of *Orobus* (*O. coccineus*) it was found that the roots

were freely invaded by the endophyte, but the latter was rapidly digested and killed by the root cells.

The evolution cycle of *Solanum tuberosum* is characterized by a well-marked alternation of the phases of differentiation and of tuberization. The tuber, on being sown, starts to develop its eyes (buds) into leaf-bearing stems with or without rudimentary flowers, while the secondary buds at the base of the stems grow into slender underground stolons which often turn upwards at their extremity and appear above ground to give rise to new leafy stems; after a certain time, the apical buds of the stolons cease differentiating into stems and begin to produce tubers, while the further development of the aerial parts of the plant is checked and they finally die. In *Orobus tuberosus*, on the other hand, once the tubers are formed by coalescence of the basal buds, they continue to grow in volume indefinitely, at the same time producing buds which develop into slender stolons which, in their turn, can produce aerial stems. Of these two typical forms of development, the first is connected with intermittent, and the second with continuous, symbiosis.

In the Ophrydeae also two different forms of development may occur according to whether the plants grow in or out of symbiosis with fungi; in the former case they are reduced to a single aerial stem and their basal buds produce perennial organs; in the latter they are bushy from the very start and possess no perennial organs. In the cases in which similar essential vegetative differences characterize two species of the same family, such as *Mercurialis perennis* and *M. annua*, the same relationship can be traced between symbiosis and the external growth of the plant. In the former, which has thick rhizomes and a stem unbranched at the base, there is a well-established endotropic mycorrhiza, while in the latter, where there are no rhizomes and the stems branch from the base, the roots are free from living fungus, though digested fragments are numerous. Statistical data as to the distribution of mycorrhiza indicate that, as a general rule, wild perennial plants harbour symbiotic fungi, while annual plants are free from them. The study of three annual plants (*Orobus coccineus, Mercurialis annua, Solanum nigrum*) has shown that, like their perennial congeners, they can be penetrated by endophytes, but that they very soon get rid of the latter by an active process of digestion which the author compares with phagocytosis. As soon as the mycelium reaches the middle layer of the cortex of the roots and begins to form into clumps, the latter are digested by the cells penetrated by them, and degenerate completely; the digested hyphae can still be recognized, but they have lost all the structural characters of a living mycelium; the protoplasm has disappeared and the walls are retracted and take a deeper stain than is usual.

The relations between endophytic fungi and the plants which harbour them may be of different kinds. Against the invasion of the former there may be a more or less successful resistance on the part of the latter. If the fungus gains the upper hand, destructive parasitism results. Successful defence is indicated by the degeneration of the fungus after a relatively brief period. When virulence and resistance balance, symbiosis is established; symbiosis is thus

a state of equilibrium between the immunity reactions of the host and the parasitic activities of the invading micro-organism. The processes made use of by the higher plants in resisting invasion are of three kinds: first, the fungus may be stopped by the mechanical resistance opposed by the cell walls of the organs attacked; secondly, when this resistance is conquered, it can be checked by a more or less early 'phagocytosis', i.e. digestion by the cells it invades; and lastly, in the case of both organisms becoming mutually adapted to life in common, it is evident that these two processes having failed to keep out or destroy the fungus, some further method must be made use of to keep its development within bounds. This the author thinks is to be sought in the physico-chemical properties of the cell-sap. He compares the formation of clumps and 'arbuscules' in endophytic fungi to the agglutination of bacteria under the influence of humoral immunizing bodies. Noël Bernard claimed to have demonstrated the presence of specific antibodies in the orchids. Fungicidal and agglutinating humoral properties are, therefore, believed by the author to reside in the cell-sap of the host plant, and to be an important means of defence against invading fungi. Thus a remarkable parallel can be drawn between the processes used by plants to resist fungous attack and the immunity reactions in animals.

The effect of the endophyte in provoking tuberization is believed to be the result of an increased concentration of the cell-sap, brought about by the enzymic activity of the fungus. This is based on the fact that tuberization in the orchids and other plants can be produced in the absence of the fungus by growing in concentrated media, and experiments have shown that certain of the endophytes increase the concentration of the solutions in which they are cultivated. Hence it is probable that, under artificial conditions of cultivation, plants like the potato develop tubers even in the absence of their endophyte, because they are grown in rich soils with a relatively high molecular concentration of the soil solution.

Romell (L. G.). **Parallelvorkommen gewisser Boleten und Nadelbäume.** [Association between certain Boleti and Conifers.]—*Svensk Botan. Tidskr.*, xv, 2–4, pp. 204–213, 4 figs., 1921.

At Kristineberg, on the west coast of Sweden, the writer was struck by the occurrence of the butter fungus (*Boletus luteus*) in fairy rings round the young plantations of mountain pine (*Pinus montana*). In other parts of the district the fungus in question is practically absent. Further investigations and inquiries in different parts of the country confirmed this association, though the fungus was also found under *Pinus austriaca* and *P. silvestris*. Similar instances have been recorded by other writers, e.g. Quélet, who states that *Boletus boudieri* occurs in association with *Pinus halepensis* and *P. pinaster* (*Flore mycologique de la France et des pays limitrophes*, 1888). So also *Boletus elegans* is found only under the larch, being present even before the special larch humus, composed of larch-needles, &c., has been formed. The writer has seen it in Swedish plantations of three-year-old larches (*Larix europea, L. sibirica*, and *L. leptolepis*).

In the case of *Boletus luteus* at Kristineberg, it was specially

noticed that no trace of any modification in the soil, due to the action of the pines, was discernible. The association cannot therefore be explained in the same way as certain other cases of specialization, such as the exclusive occurrence of *Naucoria suavis* under alders and *Tricholoma psammopus* under larch, which are due to a preference of the fungus for a particular type of humus. Wherever pines were present *Boletus luteus* showed no marked preference for any particular type of soil, thriving equally well in dry sand or heavy clay.

Attempts to trace a direct connexion between the mycelium of the fungus and the roots of the pines could scarcely be expected to give conclusive evidence that the Boleti are concerned in mycorrhiza formation, but the observations carried out lead the writer to believe that such is the case. The chief difficulty of definitely proving that these fungi form mycorrhiza is the fact that their spores have not hitherto been germinated, in spite of numerous attempts, and probably require very special conditions for germination.

SPENCER (E. R.). **Decay of Brazil nuts.**—*Botan. Gaz.*, lxxii, 5, pp. 265–292, 5 pl., 3 figs., 1921.

Brazil and cream nuts (the seeds of *Bertholletia nobilis* Miers and *B. excelsa* Humb. and Bonpl.) are harvested and transported from January to March, when heat and moisture favour fungous growth, and very often cargoes of these nuts arrive at their destination with nearly one-third spoiled. In spite of legislation, Brazil nuts reach the consumer containing from ten to twenty-five per cent. of spoiled nuts, and in 1919 the loss resulting therefrom and falling directly on the consumer, was, in the United States alone, estimated to exceed $850,000. As these nuts do not become rancid very readily, they are not placed in cold storage either during transit or on arrival, and very frequently the rooms in which they are kept by the retailer are very hot and not always dry, thus encouraging fungous attacks. The pericarps differ in porosity, and the more porous readily become infected under these conditions. The fungus may enter the nut through the pores of the shell, provided the water content of the kernel is adequate for its support, and given favourable storage temperature. Another possible, and perhaps more usual, point of entry is offered by the narrow cavity found in the micropylar angles of the seed which extends the entire length of the shell.

The following diseases are described:

1. *Black crust.* Fully five per cent. of all unsound Brazil nuts are found to have this disease, which cannot be detected externally. The affected kernel is dull black in appearance and—in cases where the whole nut is attacked—reminiscent of a large sclerotium. The blackened portion consists of a thin layer, 100 to 250 μ in thickness, and is apparently quite unconnected with the tissues beneath, which, apart from their light brown colour and pungent nutty odour, seem normal. The mycelium is confined to the endosperm, and is often free from admixture with any other organism, so that isolation is easy. The fungus is a species of *Pellionella*, differing in its conspicuously larger spores from the only species of this

genus previously described, *P. deformans* Penz. and Sacc. It is named and described as *Pellionella macrospora* n. sp.

2. *White mould.* Less common than the preceding and responsible for not quite one per cent. of the decay in Brazil nuts, this disease is not easily detected, though affected nuts are below the average in weight, and on being opened the kernel is found covered with a white fluffy mycelium, which penetrates to the centre of the radicle and fills all the cracks and cavities. Soon after exposure the very tenuous hyphae collapse and the endosperm, which is sulphur-yellow in colour and more than twice the normal thickness, becomes visible. The organism is a *Cephalosporium*, *C. bertholletianum* n. sp.

3. *Dry rot.* This is caused by a species of *Fusarium* belonging to the section Eupionnotes of Wollenweber. The shell of affected nuts is mottled, and on the whole the colour is lighter than normal, while the weight is much below the average. The kernel is sound in appearance, but adheres more closely to the shell, and is in reality a mass of mycelium. No perithecia were observed in culture, but sclerotia appeared on autoclaved rice.

4. *Aspergillus decay* has already been reported by Kuhl ('Ueber eine eigenartige Veränderung der Paranuss,' *Pharm. Zentralb.*, li, p. 106, 1910). The cases examined by the author are not easily detected, as there are no external symptoms except in the most advanced stages of the disease, when there is appreciable loss in weight. The odour of the affected kernel is very rancid and slightly putrid, while the taste is at first sour and later very bitter. It is thought that the disease is far more prevalent than commonly believed, but in its advanced stages it is less frequently met with than 'black crust'. Kuhl considers that nuts affected by the fungus, which he identified as *A. flavus* Mont., are poisonous, and states that the discoloration caused by it is not pronounced enough to prevent their consumption. The mycelium penetrates to the centre of the radicle, and appears as a white mould on the walls of the central locule, which is filled with a mass of spores when the kernel cracks open. Cultures submitted to Thom were stated to belong to the *A. tamari* series [see this *Review*, i, 3, p. 91].

5. *Bacterial decay.* A hitherto apparently undescribed spore-bearing bacillus, with which the author is dealing in a separate paper, occurs on Brazil nuts, rendering the shell black and greasy, usually causing a rancid odour, and converting the remains of the kernel into a small white mass.

6. *Actinomyces decay.* This is due to an apparently undescribed species, to which the author has given the name of *Actinomyces brasiliensis*, n. sp. The nuts affected with this disease are empty, and give a characteristic musty odour when opened. The inner shell wall is covered with pinkish, velvety pustules, having a diameter of one to several millimetres. An intercellular proteolytic enzyme is produced by this organism, and also by the bacillus mentioned in the preceding paragraph.

7. *Phomopsis decay.* Of the experimental nuts, which were bought from wholesalers and retailers, only one was found affected with this disease. It is due to *Phomopsis bertholletianum* n. sp., a species differing from *P. aucubicola* Grove only in having shorter

A-spores and in occurring on an unrelated host. There is no external symptom of the diseased condition of the nut, the odour being pleasant and taste agreeable even when the mycelium has penetrated into the radicle a considerable distance.

8. *Bitter rot* is caused apparently by a *Myxosporium*, but examination could not be carried far, as neither the mycelium nor the spores in the specimen to hand were viable.

The organisms mentioned are fully described, and notes on their cultural characters are given.

ATKINS (W. R. G.). **Note on the occurrence of the finger and toe disease of Turnips in relation to the hydrogen-ion concentration of the soil.**—*Scient. Proc. Royal Dublin Soc.*, xvi, N. S., 32, pp. 427–434, 1922.

The occurrence of the finger and toe disease (*Plasmodiophora brassicae*) has been associated for a long time past with a deficiency of calcium salts in the soil. The author has recently examined soil samples from two adjacent fields in Cork County, of which one grew healthy turnips without a trace of the disease, while the other was so badly infected that turnips or cabbages could not be grown in it. The soil in both these fields was clay, but they contained 0·17 and 0·40 per cent., respectively, of lime, the latter being in that which bore healthy crops. The calcium content in this case is very near the border-line for the occurrence of the disease, previous observers having reported it in clay soil with 0·39 per cent. of lime. The acidity of the samples was determined by the colorimetric method, the bad field being found more acid than the good field by P_H 0·1 (P_H 6·6 and 6·7 respectively). The actual numerical concentrations of hydrogen ion were, respectively, C_H 0·25 and $0{\cdot}20 \times 10^{-6}$ gm. per litre.

The exact manner in which a deficiency of calcium salts makes the plant more susceptible is not known, the possibility that it is due to an inhibitory action of a neutral or slightly alkaline medium on the growth of the parasite requiring to be tested by more exact methods (such as that here employed) of determining the acidity of diseased and healthy plants.

ERIKSSON (J.). **Das Leben des Malvenrostpilzes (Puccinia malvacearum Mont.) in und auf der Nährpflanze.** [Life of the Mallow rust fungus (*Puccinia malvacearum* Mont.) in and on the host-plant.] *Kungl. Svenska Vetenskapsak. Handl.*, lxii, 5, 190 pp., 31 figs., 1921.

As a result of observations and experiments extending over the period from 1912 to 1920, the author considers that there are two distinct stages or phases in the vegetative development of the common Mallow rust, *Puccinia malvacearum*. The first of these is the ordinary mycelial condition resulting from infection from sporidia produced on a normal short promycelium. The mycelium developed from these sporidia produces new rust sori in eight to ten days after infection. The other phase corresponds with the author's well-known conception of the mycoplasm, and is derived from infection by conidium-like bodies produced on the end of a long germ-tube by segmentation of the tip of the latter. It does

not form sori while in the mycoplasmic stage. The teleutospores formed by this rust are of two kinds, indistinguishable morphologically. One, which the author terms autumn spores, is borne on young plants in the first season of their growth and on second-year plants from the end of July to October. These spores can germinate according to circumstances in both the manners referred to above—either by forming a promycelium and sporidia or by a germ-tube with conidia. The second form, the summer spores, is developed on second-year plants during the months May, June, and July. It germinates only by the formation of a germ-tube with conidia. Hence the autumn spores can give rise to either a normal mycelium or a mycoplasm, while the summer spores form only the latter.

The course of the disease corresponds to these two functions of the infecting spores. In newly-planted plants there may be a period of complete freedom from infection, followed by a period of mild attack in June and July. This is followed again by a period of very severe infection in August when every leaf may become covered with pustules. In certain cases the first period of mild infection does not appear, and the author distinguishes the plants in which this occurs as belonging to 'healthy lines'. Such healthy lines, if kept free from outside infection, will grow through the autumn without showing any signs of rust, but they will become infected in late July or early August if growing near previously diseased plants belonging to what the author calls 'diseased lines', that is those which show the early period of mild attack. In the author's view the healthy lines become infected by the autumn spores borne on the diseased lines. These autumn spores appear in the first year (on plants sown in May or June) during September and October, but also reappear in the second year as early as the end of July. Healthy lines infected by them become diseased lines. In some cases the autumn generation of the fungus persists into the spring of the following year and may lead to infection with a development of sori on healthy lines in the vicinity as early as May. This was only observed in 1914. When precautions were taken to remove all diseased or suspicious leaves, &c., that had lasted through the winter, only the usual mild outbreak occurred in May to July.

The two phases of the vegetative life of the parasite are differently affected by the action of fungicides added to the soil. Weak solutions of copper sulphate (1 to 3 per cent.) will check the development of the mycoplasmic stage, and can produce a decided effect in reducing the first or mild period of the annual rust outbreak from May to July. They have no effect whatever on the second, virulent, period from August to October. The solution was found not to injure the hollyhock plants in concentrations below 6 per cent.

It is believed that the vitality of the pathogen in diseased lines may become lowered under certain conditions. Thus, in 1915 and subsequent years the first (mild) period of attack was absent in several of the diseased lines; and in 1918 and 1919 two diseased lines became healthy, presumably from the extinction of the vitality of the internal germ. A heavy outbreak in the autumn on seedlings

of the first year is not necessarily followed by a severe attack on the same plants in the second year of their growth. There are also indications of varietal and individual variations in resistance and susceptibility to the rust.

BROWN (W.). **Studies in the physiology of parasitism. VIII. On the exosmosis of nutrient substances from host tissue into the infection drop.**—*Ann. of Botany*, xxxvi, 141, pp. 101–119, 1 fig., 1922.

In the earlier papers of this series attention was chiefly directed to certain aspects of the influence of a parasite on the host plant which it attacks. The converse relation of host to parasite is examined in the present paper, as it appeared not improbable that the host plant might be able to influence in some way the behaviour of the parasite.

The author gives a detailed description of a series of experiments carried out by him with a view to establishing the influence of passive exosmosis of nutrient materials from the cells of the host plant through the cuticle on the behaviour of a parasite prior to penetration. The method of experiment was generally as follows: drops of distilled water of a standard size were laid on the surface of plant organs (foliage leaves and petals of flowers) and allowed to remain there for a certain time. They were then removed and examined to see whether any change had taken place in them due to their having been in contact with the plant. Two methods of examination were adopted: (1) determination of the electrical conductivity of the fluid, and (2) determination of the effect of the fluid on the germination of fungal spores, *Botrytis cinerea* being the organism used in the tests.

The conclusions arrived at by the author are that drops of water that have lain on the surface of the leaves and petals of a number of plants show increased conductivity (due to the leaching of electrolytes from the tissues) as compared with the original distilled water or with water which has lain for an equal time on glass slides. The amount of this increase varied with different plants used in the experiments, an important factor being the ease with which the surface can be wetted. If a new drop is placed where a previous one has been removed for testing, the exosmosis is increased. Rubbing the surface, even though gently, also increased the conductivity figure obtained. Better contact, through better wetting, appears to be the main cause of the increase in both these cases. In many cases (especially floral leaves) there is a marked parallelism between this increase in conductivity and the increase in the capacity of the drops to promote the germination of spores as compared with that of the original water. In some plants, however (e.g. broad beans), drops that have lain on foliage leaves, though showing a comparatively high degree of conductivity, display no greater power of promoting spore germination than drops of pure water, and sometimes (*Tradescantia*) may actually give a lesser germination, even extending to almost total inhibition. Not only is there a quantitative difference in the substances exosmosed from different plants, but evidently there is a qualitative difference also, these substances sometimes having no nutrient value or even

inhibiting germination. Indirect proof of the exosmosis of nutrient materials can be obtained by a study of the incubation times of infection in different cases. The addition of nutrient to the infection drop has the effect of accelerating the incidence of attack, or in extreme cases brings about attack where none ordinarily occurs (e.g. on leaves of broad bean). Hence it might be anticipated that in plants which allow a large exosmosis to take place into the infection drop the time required for infection would approximate to that required for spores sown in a nutrient-extract infection drop, while in those that do not allow free exosmosis it would be delayed. It was found that with petals of *Cereus*, which allow free exosmosis, spores sown in pure water attacked almost as readily as those sown in turnip extract, whereas with *Gloxinia*, which gives a low conductivity figure in drops placed on the petals, the former attacked distinctly more slowly than the latter. A similar result was obtained when rose petals and those of *Cereus* were inoculated in an atmosphere of carbon dioxide, which is known to inhibit the germination of *Botrytis* spores, but can be neutralized by the addition of nutrient material; the former (which earlier tests had shown to give a low conductivity figure) were unattacked, the latter attacked. A further test was based on the fact that *Botrytis* spores will not germinate in pure water if sown too densely, but will do so at the same density in a nutrient solution. On *Cereus* petals the exosmosis of nutrient was evidently sufficient to permit germination at high densities of sowing, and free infection resulted, while with sweet pea, which gave a lower conductivity figure in the earlier experiments, there was little infection.

The rate of exosmosis into drops containing spores is identical with that into spore-free drops, up to and for some time after penetration by the fungus has taken place. This affords a striking confirmation of the view expressed in the earlier papers of this series that there is no diffusion of the active toxic principle of *Botrytis* through the unbroken cuticle, and that there is no effect on the host plant prior to this penetration, in other words, no 'action in advance of penetration', as claimed by earlier workers with this fungus.

Though these results do not touch on the problem of immunity in such cases as are furnished by some of the rusts, they have a bearing on a certain type of immunity such as that shown by bean leaves against *Botrytis*. Here the incidence of attack is dependent on the nutrition present in the infection drop. If there is no nutrient the attack fails, but if nutrient is present it takes place readily. [See also this *Review*, i, 1, p. 7.]

SOMMER (H.). **Kohlhernie-Bekämpfung mit Uspulun im Jahre 1921.** [Control of club-root of Cabbage with uspulun in the year 1921].—*Deutsche Obstbauzeit.*, lxviii, 5, pp. 43–44, 1922.

The application to heavily infected soil of a minimum strength of 0·5 per cent. solution of uspulun, preceded if possible by similar treatment of the plants in frames, almost entirely arrests the disease. Inoculation of the seed-bed soil with uspulun powder (120 gm. per sq. metre) gave less satisfactory results, but in the writer's opinion this was due to the fact that the seed was sown on

the same day. Eight to ten days should elapse between inoculation and sowing, and the soil should be well watered immediately the powder has been mixed in.

Regulations for the importation of Potatoes, Currants, and Gooseberries into Canada.

By Orders in Council passed on 21 March 1922, the sections of the Regulations under the Destructive Insect and Pest Act, Canada, dealing with potato canker [wart disease, *Synchytrium endobioticum*] and the importation of currants and gooseberries on account of White Pine blister rust [*Cronartium ribicola*] were amended as follows: Subsection (a) of Section 7 was rescinded and the following substituted: Section 7. The importation into Canada of the following is prohibited: '(a) Potatoes from Europe, Newfoundland the Islands of St. Pierre and Miquelon, and the States of California Pennsylvania, and West Virginia. All shipments of potatoes from the United States of America shall be accompanied by a certificate duly signed by the consignor or stating the name of the State in which the potatoes were grown.'

The amendment under subsection (f) of Section 7 passed on 4 April 1919, was rescinded and the following substituted: Section 7. The importation into Canada of the following is prohibited: '(f) All species and varieties of currants and gooseberries (*Ribes* and *Grossularia*), but not including the fruits of these. from all foreign countries. Provided, however, that the importation of said vegetation shall be permitted without any restriction into the province of Ontario from the State of New York.'

Regulations governing the importation of Potatoes into the United States.—*U.S. Dept. of Agric. Federal Hortic. Board, Washington D. C., Letter of Transmittal*, 7 pp., 17 Feb. 1922.

The following regulations are adopted and shall be effective on and after 1 March 1922, and shall supersede the regulations governing the importation of potatoes into the United States, which were promulgated to take effect on and after 1 March 1921. Regulation 2 is amended in such a way as to permit the entry of potatoes only from countries free from potato wart or other injurious potato diseases and insect pests new to or not widely prevalent or distributed within and throughout the United States. Such country must further agree to examine and certify all potatoes offered for export in compliance with these regulations. Potatoes will be admitted into the United States only through the port designated in the permit, and the entry of potatoes will only be permitted if the exporting country has an effective quarantine prohibiting the importation of potatoes from any country known to be invaded by potato wart or other injurious diseases or pests. Consignments of potatoes will be submitted to inspection at the port of entry. Except in cases of bulk shipments, only containers not previously used for potatoes are to be employed.